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SECTOR PLAN FOR HALON PHASE-OUT IN CHINA

(Submitted by the World Bank)

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INTRODUCTION

A. Background

1. China joined the *Vienna Convention for the Protection of the Ozone Layer* in September 1989, and ratified the London Amendment of the *Montreal Protocol On Substances That Deplete the Ozone Layer* two years later. Since then, China has been committed to the phaseout of ozone depleting substances (ODS) in accordance with its designation as one of the Article 5 countries classified by the Protocol. On January 12, 1993, the Chinese government approved the China Country Program for Phaseout of Ozone Depleting Substances, and started to implement phaseout actions in China for ODS with the support of the *Multilateral Fund For Implementation of the Montreal Protocol* (MLF).

2. Over the past several years, the government has established a Leading Group for Ozone Layer Protection and its working offices to organize phaseout actions. This group has been responsible for the following phaseout activities: issued a set of regulations to control the production and consumption of ODS; compiled phaseout strategies for all ODS-related sectors; and publicized information about ozone layer protection throughout the country. With support from the MLF, China began to phase out ODS using a project-by-project approach. China has approved and is implementing about 160 specific projects for ODS phaseout; and had closed and converted ODS-related enterprises; and had phased out ODS production amounting to about 6,000 metric tons by 1995.

3. The phaseout approach characterized as "project-by-project" does play a role in ODS phaseout action in China. However, such an approach has limitations in large, complex, fast-growing economies such as China's. The current method of individual project preparation and approval fails to encourage strategic phaseout and makes potential sector-level savings difficult to capture. Also, absent a policy framework, ODS phaseout project implementation may not translate into sector or national level ODS reductions, especially as projects are implemented in advance of Montreal Protocol phaseout controls. Due to the large number of diverse enterprises in China, phaseout on a "project-by-project" basis is unlikely to be the most efficient way of meeting the requirements in China for ozone layer protection. Determining the most efficient method of ODS phaseout without imposing too great a burden on a rapidly growing economy is a primary concern.

B. The Sector Approach and Mechanism Study for Halon Phaseout

4. At the Xi'an Workshop on ODS Phaseout Sector Strategies in June 1995, the Secretariat of the MLF, as agreed by the Chairman and Vice Chairman of the Executive Committee of the MLF (MFEC), put forward the concept of a "sector approach" with the expectation of improving the efficiency and accelerating the progress of ODS phaseout. In response to this proposal from the Secretariat, the Chinese government acknowledged

the benefits of introducing a sector approach, and expressed an interest in implementing this approach, as well as the willingness to explore new, more efficient ways to promote the phaseout action.

5. At its 17th Meeting, the MFEC approved project preparation resources for 'further development by the World Bank of the sectoral strategies.' (Decision 17/35) The Bank had requested these funds on behalf of the Government of China to design a sector-based approach with two primary objectives: (a) to reduce the unit costs of phaseout both to China and to the Multilateral Fund; and (b) to allow the Executive Committee to manage the Fund's resources based on actual ODS phaseout performance. The fire protection sector was selected by the Chinese government as the candidate to pilot the sector approach.

6. In terms of ozone depletion potential (ODP), the ODS consumed by the Chinese fire protection sector, halon 1211 and halon 1301, accounts for more than one third of the country's total ODP consumption. From this point of view, phaseout of halon in the fire protection sector is essential for the effective implementation and enforcement of the overall Country Program.

7. Research organized by the National Environment Protection Agency (NEPA), the Ministry of Public Security (MPS) and the World Bank, has been conducted by experts from the Center for Environmental Sciences of Peking University, Tianjin Fire Protection Sciences Research Institute of MPS, China International Economic Consultants, Inc., and the World Bank. The study of a sector phaseout mechanism was finished in May 1996, and a revised Fire Extinguishing Sector Plan for Halon Phaseout in China was developed in June 1996 and reviewed in July-August 1996. A *Sector Plan for Halon Phaseout In China* was submitted on an information basis to the 20th MFEC Meeting (UNEP/OzL.Pro/Excom/20/Inf.3). At its 21st Meeting, the MFEC provided "Initial Guidance To Allow Further Development By China and the World Bank of the Halon Sector Approach Pilot Program Under an Umbrella Agreement." This Sector Plan has been prepared following that initial guidance.

8. The research confirms that adoption of the sector-based mechanism will:

- (a) Improve the comprehensive planning and management by concerned ministries and departments of the government for taking action on an overall phaseout plan;
- (b) Improve the implementation of economic incentive instruments;
- (c) Reduce the uncertainty of halon phaseout;
- (d) Improve the efficiency of resources from MLF; and
- (e) Achieve the overall phaseout strategy for halon.

C. Principles and Contents of the Plan

9. This sector phaseout plan has been established on the basis of the Chinese Government's obligations undertaken under the *London Amendment of the Montreal Protocol on Substances that Depleting the Ozone layer*, the *Vienna Amendment of the Protocol*, and the *Chinese Country Program on Substantially Phasing Out Ozone Depleting Substances*, and also taking into account the related provisions of the *Copenhagen Amendment of the Protocol*. The plan also accommodates the specific characteristics of the national economic and social development plan and strategy, and the specific development plan for the fire protection sector. The technical support documents of the phaseout plan are consistent with MLF's principles and guidelines, as well as related documents about incremental costs. This sector plan revises China's June 1995 report *Halon Phaseout Strategy for Fire Extinguishing*.

D. Principles

10. The fire protection capability of China must not be jeopardized by the phaseout of halon.

11. MLF should supply the level of eligible funds required to finance the phaseout and facilitate the transfer of the alternative technologies required for the phaseout of halon.

12. On the assumption that MLF approves the sector plan and disburses funds on time according to the annual plan, the Chinese government commits to implement the halon phaseout, and comply with the overall targets and annual targets determined in the Fire Extinguishing Sector Plan for Halon Phaseout in China.

13. The Chinese government will phase out halon in a cost-efficient way.

14. The Chinese government will engage an experienced management institution and set up a reasonable mechanism for managing and implementing the halon phaseout; issue and implement necessary regulations and policy instruments; ensure provision of technical support; and implement related publicity and educational activities.

15. As implementing agency for the halon sector phaseout plan, the World Bank will be responsible for appraising, endorsing and supervising the overall program through an umbrella agreement.

E. Content

16. Based on a comprehensive investigation of halon production and consumption in China and a careful analysis of past phaseout experiences are presented in chapter one including policy and other phaseout actions to date. Chapter two discusses proposes essential policy actions and supporting instruments that would be adopted upon approval by the MFEC of this sector plan. Based on results from a cost model, chapter three explains the total incremental costs to China of halon phaseout and the eligible costs requested from the MLF. A detailed action plan for the first implementation period

(through 1998) in accordance with the selected halon phaseout schedule is specified in chapter four. Finally, in chapter five, the management mechanism, including monitoring, evaluation and reporting provisions are defined to ensure full implementation of the plan.

F. Announcement

17. The implementation of this Sector Plan for Halon Phaseout in China will not affect the implementation of the projects that have already been approved. Moreover, the sector plan takes into account the halon projects already approved by the MFEC to avoid double counting.

18. The Sector Plan for Halon Phaseout in China is specifically targeted for the fire protection sector. The phaseout methods, cost analysis methods adopted by the plan can only be considered as references to other ODS-related sectors, and cannot be used as models or prerequisites in the ODS phaseout action of other sectors or other countries.

19. The financial mechanism proposed for the phaseout of halon will apply only to the sector-based phaseout activities implemented through the World Bank.

I. CURRENT STATUS OF THE FIRE PROTECTION SECTOR AND OVERALL STRATEGY FOR HALON PHASEOUT

A. Sector Background

1. Adequate and cost-effective fire protection is an important contributor to sustainable economic development. In order to provide an adequate level of fire protection, the Chinese government has been promoting the development and production of fire protection equipment, and developing and establishing production quality control systems and regulations concerning fire protection standards. However, because of rapid economic growth it has been a strain for the development of fire protection capacity to keep pace with domestic demand, particularly in relation to international standards. Under these circumstances the accelerated elimination of halon from the Chinese fire production industry is a particularly burdensome undertaking, requiring substantial financial and technical resources.

B. Management of the Fire Protection Sector

2. The Ministry of Public Security (MPS) is responsible for overall planning and management of fire protection equipment, including research and development and production activities. According to the *Fire Protection Code (Regulation) of People's Republic of China*, MPS is responsible for organizing, compiling and revising technical standards of the fire protection and production plan of fire protection equipment; and enforcing the monitoring, publicity, education, training and research activities related to fire protection.

C. Production and Consumption of Extinguishing Agents and Fire Extinguishing Equipment

3. There are approximately 470 factories involved in the production of fire protection agents, extinguishers and extinguishing systems in China (of which 117 factories are producing chemicals, 320 are producing extinguishers, and 33 are producing extinguishing systems). The enterprises producing chemicals can produce BC and ABC powder, foam, CO₂, and halon 1211 and halon 1301; the extinguisher enterprises produce hand-held and wheeled extinguishers using these chemicals; and systems enterprises produce water sprinkler systems, steam systems, and systems using halon 1211, halon 1301, foam, powder and CO₂. In 1995, the total production of extinguishing chemicals in China was approximately 72,000 tons.

4. Past trends in production and consumption can be established only in approximate terms, since systematic data have not been collected by the authorities. Surveys conducted by MPS over the past year have improved the coverage of reporting and the accuracy of production and consumption data. However, it is likely that data for 1995 represent more complete coverage of the industry than the figures for earlier years. Production and consumption are given in Table 1-1;

consumption in extinguisher production is in Table 1-2; and consumption in fixed system production in Table 1-2.

TABLE 1-1: PAST PRODUCTION AND CONSUMPTION OF AGENTS (MT)

	1991	1992	1993	1994	1995	# of producers (1995)
Halon 1211						
Production Capacity					17,800	
Actual Production	4,000	5,464	6,532	6,850	9,950	14
Import	0	0	0	0	0	
Export	0	0	0	0	1,400	
Domestic consumption	4,000	5,464	6,532	6,850	8,550	
of which use for:						
new extinguishers	3,910	4,955	5,769	6,010	7,309	
new systems	0	304	377	330	551	
service	90	205	386	510	690	
ABC Powder						
Actual Production	0	0	800	1,500	2,000	5
Domestic Consumption	0	0	800	1,500	2,000	
of which use for:						
new extinguishers	0	0	800	1,500	2,000	
servicing	0	0				
CO₂						
Actual Production	0	0	200	500	500	
AFFF						
Domestic Consumption	0	0	500	1,000	1,000	3
BC Powder						
Domestic Consumption	21,691	23,421	26,619	33,433	39,727	50
Foam						
Actual Production	10,737	11,594	13,176	16,550	19,665	36
Domestic Consumption	10,737	11,594	13,176	16,550	19,665	
of which use for:						
new extinguishers	1,627	1,757	1,996	2,508	2,980	
new systems	9,110	9,837	11,180	14,042	16,685	
Halon 1301						
Production Capacity					1,000	
Actual Production	50	68	120	540	750	1
Import	40	50	NA	NA	NA	
Export	0	0	0	240	450	
Domestic Consumption	90	118	120	300	300	
of which use in:						
new extinguishers	0	0	0	0	0	
new systems	82	110	110	280	277	
service	8	8	10	20	23	
Total consumption	36,518	40,597	47,947	60,133	71,742	

Note: Domestic consumption = Production + Import - Export. Domestic consumption includes consumption of agent for extinguishers, extinguishing systems and servicing (retirement and refilling).

5. From 1991 to 1995, total chemical use in fire protection nearly doubled, reflecting the rapid growth in the Chinese economy and improved fire protection quality. However, the level of fire protection in 1995 is well below international standards, particularly considering that much of BC and ABC powder has low product quality. The main market for chemicals is in extinguishers with 74 percent of the market share.

6. In 1995, the predominant fire protection chemicals produced were BC powder, 39,000 tons or 55 percent, and halon 1211, 9,950 tons or 14 percent of total production, respectively. However, in terms of fire extinguishers, halon 1211 covered 22 percent of the market with BC powder at 69 percent. BC powder is favored due to low cost, and halon 1211 because it is easy to handle, low hardware requirements and its versatility in many applications. Other chemicals have only recently been introduced but all face marketing problems due to high cost and/or product quality considerations. Halon 1301 use has increased recently.

7. The average annual growth rate for fire protection between 1991 and 1995, according to the figures in Table 1-1, was 18 percent. However, taking into account the changing data coverage over time, it is estimated that underlying growth rate was approximately 15 percent per annum (i.e., early 1990 production and consumption figures were likely higher than reported).

TABLE 1-2: AGENTS CONSUMED IN NEW EXTINGUISHERS (MT) AND NUMBER OF EXTINGUISHERS PRODUCERS('000 IN BOLD)

Extinguisher Type	1991	1992	1993	1994	1995	# of manufacturers (1995)
Halon 1211						
agent consumed	3,910	4,955	5,769	6,010	7,309	
extinguishers	1,955	3,040	3,390	3,570	4,213	72
produced						
ABC powder						
agent consumed	0	0	800	1,500	2,000	
extinguishers			267	500	667	
produced						
CO ₂						
agent consumed	0	0	200	500	500	
extinguishers			33	83	83	
produced						
AFFF						
agent consumed	0	0	500	1,000	1,000	
extinguishers			63	125	125	
produced						
BC powder						
agent consumed	21,691	23,421	26,619	33,433	39,727	
extinguishers	7,230	7,807	8,873	11,144	13,242	
produced						
Foam						
agent consumed	1,627	1,757	1,996	2,508	2,980	
extinguishers	542	586	665	836	993	
produced						
Total Agents:						
agent consumed	27,228	30,133	35,884	44,951	50,536	
extinguishers	11,354	11,433	13,816	17,068	19,323	
produced						

Note: Data are indicative: calculations are based on the 1995 survey and estimates by MPS

TABLE 1-3: AGENT CONSUMED IN EXTINGUISHING SYSTEMS (MT)

	1991	1992	1993	1994	1995
Halon 1211	0	304	377	330	551
Halon 1301	82	110	110	280	277
Foam	9,110	9,837	11,180	14,042	16,685
Total	9,192	10,251	11,667	14,652	17,513

Note: Figures on Halon 1301 fire extinguishing systems do not include halon imported in systems. A large number of halon fire extinguishing systems have been imported as part of joint venture projects and in special risk areas such as the oil and gas, power sector, telecommunication.

D. Analysis of halon enterprises

8. **Enterprises producing halon.** In 1994, China had 23 factories capable of producing halon 1211 and one producing halon 1301, including both state-owned and township-owned¹. The factories range in size from very small, with production of less than 100 tons a year, to plants able to produce several thousand tons. Based on detailed surveys information received from all halon 1211 producers, the enterprises, based on profit-rate, actual production and expected plant life may be divided into two groups: large plants with production of 2,000 tons or more per year and medium to small plants those with production is under 2,000 tons per year. Most plants were established between 1986-1989, but due to better equipment and greater investment in maintenance at the two large facilities, their plant life is expected to be about five years longer than that of the small facilities (average remaining life for large plants is 13 years, whereas it is eight years for small plants). Also, due to superior technical processes, distance from raw material suppliers, and economies of scale economies of scale, large plants enjoy a higher profit margin than the smaller ones.

9. Of the 23 factories capable of producing halon 1211, 8 factories, largely at the small end of the capacity spectrum, have already closed with support from the Chinese government, and the halon unit at Tongxiang fertilizer factory was closed and its equipment demolished in 1995, subsequently receiving compensation for labor displacement through the MLF. Currently, there are 14 factories in operation, with production in 1995 of 9,950 tons of halon 1211². The single halon 1301 factory produced 750 tons of halon 1301 in 1995. Exports of both halon 1211 and 1301 have grown recently in response to the halt in production in developed countries in 1994 (See Table 1-1). The size distribution of enterprises producing halon 1211 and their share of total production are shown in Table 1-4.

¹ All halon producing plants in China are Chinese owned.

² The "Halon Phascode Strategy for Fire Extinguishing" (1995 Halon Strategy) presented in Xi'an in Jun 1995 lists production at 12 of the 23 halon producers. In fact, 14 are still producing halon. In addition, halon 1211 production capacity, due to confusion over definition, was significantly underestimated in the 1995 report.

TABLE 1-4: ENTERPRISES PRODUCING HALON EXTINGUISHING AGENT IN 1995

	Small-Medium	Large	Total
Enterprise size (according to production)	< 2,000 tons	>1,999 tons	
Number of enterprises	12	2	14
Production	5,200 tons	4,750 tons	9,950 tons
Share of production %	52%	48%	100 %

10. **Enterprises Producing Halon Extinguishers.** In 1994, there were 83 factories producing halon extinguishers in China, including both state-owned and township-owned³. They range in size from small plants capable of producing ten thousand extinguishers, to factories with a capacity of up to half a million units. Within the 83 factories, nine factories, again chiefly small plants, have already closed with support from the Chinese government, and a further two have converted with MLF support. Thus, by 1996 there remained 72 factories requiring further conversion or closure assistance. These 72 enterprises produced a total of 4,213,000 units of halon 1211 extinguishers and consumed 7,309 tons of halon 1211 in 1995.⁴ The sector phaseout plan considers only the remaining 72 enterprises. The size distribution of halon extinguisher enterprises and their share of total production are shown in table 1-5. The table illustrates the typical small scale of production in China.

TABLE 1-5: ENTERPRISES PRODUCING HALON 1211 EXTINGUISHERS IN 1995

	Small	Medium	Large	Total
Enterprise size (according to production)	0-20,000 units	20-75,000 units	above 75,000 units	
Number of enterprises	20	25	27	72
Production (units)	191,000	905,000	3,117,000	4,213,000
Halon Consumption (Tons)	404	1,814	5,091	7,309
Share Of Production % ^{1/}	5.5%	24.9%	69.6%	100%

1/ In terms of halon consumption

³ All halon fire equipment producers are Chinese owned.

⁴ The "1995 Halon Strategy" projected 1994 extinguisher production to reach 4,230,000 units, however, actual production was only 3,570,000 units in 1994. The amount of halon consumed in new extinguishers for 1992-94 was also over estimated in the 1995 Halon Strategy due to incorrect assumptions about the average size of halon extinguishers being produced.

11. **Current enterprises producing halon extinguishing systems.** China uses two different types of halon fire extinguishing systems. One consists of "stand-alone-cylinders" with typically 10 kg to 35 kg of halon 1211, each cylinder is individually sprinkler head activated. This type of system is normally produced by extinguisher manufacturers. The second type are larger extinguishing systems with centralized storage of halon, a distribution network of steel pipes and nozzles, and either a manually operated activation system, and/or activation through an automatic fire detection system. In 1995, there were 22 factories producing the second type of halon extinguishing systems in China, including both state-owned and group-owned plants⁵. 551 tons of halon 1211 were consumed in new halon 1211 system installations, and new halon 1301 systems consumed 277 tons of halon 1301.

12. **Import and export of halon extinguishers and agents.** Currently, China does not import halon extinguishers and agents, and does not export halon extinguishers. In 1995, China exported 1,400 tons of halon 1211 and 450 tons of halon 1301 to Article 5 countries in South East Asia, Latin and South America, the Middle East and West Asia. Halon 1301 fire extinguishing systems have been imported directly, but no data are available on number of systems or quantity of halon.

E. Forecast of Fire Protection Needs

13. The fire protection industry in China has grown rapidly in the recent past, paralleling the growth of the economy, investment, construction and real estate. In view of statistical weaknesses in the historical data for fire protection equipment production, it is difficult to establish a strong and reliable correlation in China between the growth of fire protection and any other variables as a basis for making demand projections. This is partly because the production data for agents and extinguishers prior to the past couple of years are considered to be incomplete, and partly because there was some suppressed demand in the past because of supply shortages and effective restrictions on imports. As previously noted, despite statistics showing average annual growth of 18%, the underlying growth rate was more likely about 15 percent per annum from 1991-95.

14. In view of this historic growth rate, a demand projection has been made considering: (a) Chinese requirements in present codes and standards for fire extinguishers and systems; and (b) current economic developments in China. Over time, it is expected that China's growth rate of fire protection will increasingly be determined by the rate of growth of the economy in general. However, for several more years, it is anticipated that fire protection growth will continue at a level above that of the economy, because there remains a strong element of "catching-up" in the industry, especially as regulation and monitoring improve. The overall projection of growth of fire protection is based on the following considerations:

- (a) China is a developing country that has been experiencing rapid growth—annual average GDP growth of 12 percent between 1991 and 1995. It is anticipated by the Bank and other economic observers that growth will continue to run at least at 10 percent per annum until 2000, although the government's own target outlined

⁵ All halon system manufacturers are Chinese owned.

in "the Ninth Five-Year Plan and Outline Objective for 2010 for the Chinese Economy" is for growth of 8 percent per annum between 1996 and 2000.

- (b) According to the "Chinese Statistical Yearbook", building area has been growing at 14 percent per annum between 1991 and 1995, propelled by rapid growth in major urban areas and special economic zones. Although new starts on commercial construction in major urban areas are reported to have declined in the last year, there remain large projects underway which will maintain the growth for fire protection for several years, and it is believed that slowdowns in new construction in some areas are being offset by diversification of investments to new areas. Thus, it is expected that growth of commercial construction will continue at close to historical levels for several years;
- (c) Following several significant fire disasters in China between 1993-95, MPS adopted stricter codes and standards which increased fire equipment requirements per square meter of occupied building space. Enforcement of these codes in existing buildings has also contributed to demand pressures and is expected to continue for several more years.
- (d) The annual average growth rate of halon 1211 and halon 1301 consumption between 1991 and 1995 was 21 percent and 36 percent, respectively, reflecting consumer and producer preference for what has been a low-cost and convenient fire protection agent; and
- (e) Servicing needs for and annual retirement of the existing stock of extinguishers and systems have been at low levels in the past, according to the limited statistics available. However, they are likely to increase, both as the stock increases and as regulation governing inspection and servicing are applied more consistently.

15. The demand projection shown in table 1-6 and figure 1-1 has been constructed on the basis that the aggregate growth of fire protection (expressed in terms of extinguishing agent) will continue at the current rate of 15 percent. After 2000, overall fire protection, including halon, is assumed to increase at 10 percent per annum.

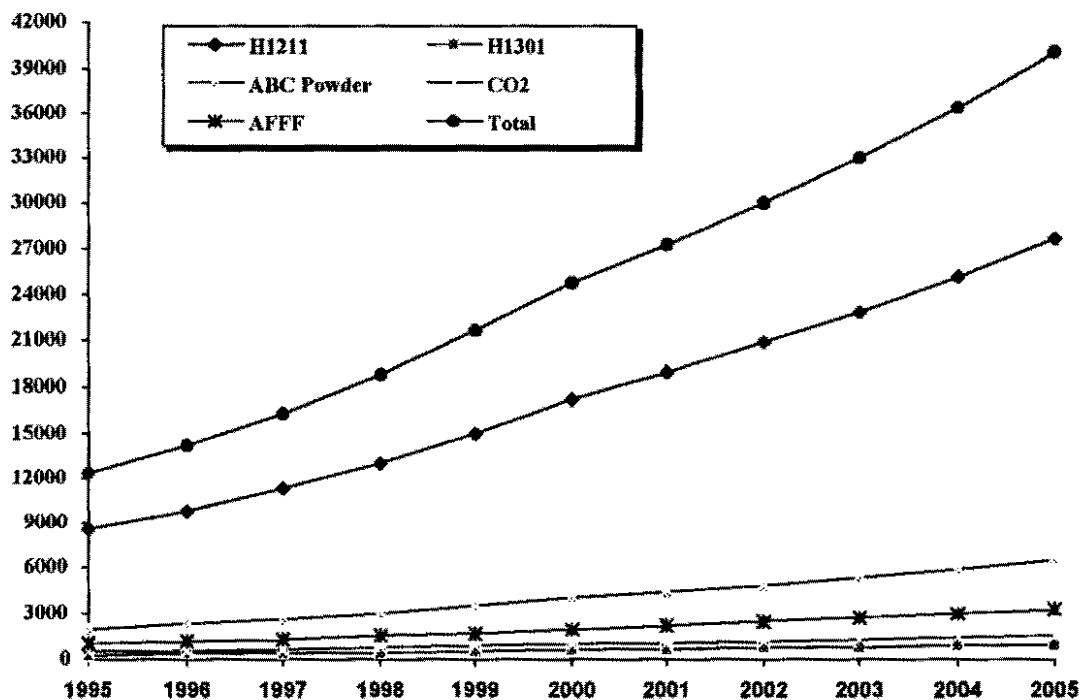
16. The demand projection assumes that the structure of the market will resemble that prevailing in 1995. In other words, the future growth rates of all forms of fire protection are assumed to be identical. The data in table 1-1 indicate that the growth of halon extinguishers and systems has tended to outpace the overall growth of the market, because of the advantages of halon-based fire protection perceived by consumers. As a result, halon has developed a large market share in China (over 20%), by international standards, and it is assumed that without more aggressive phaseout activities, halon would at the very least continue to maintain its market share.

TABLE 1-6: DOMESTIC CONSUMPTION FORECAST OF HALON EXTINGUISHING AGENT AND ITS SUBSTITUTES UNDER UNCONSTRAINED CONDITIONS (TONS)

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	200
Halon 1211	8,550	9,833	11,307	13,003	14,954	17,197	18,917	20,809	22,889	25,178	27,696
Halon 1301	300	345	397	456	525	603	664	730	803	883	972
ABC	2,000	2,300	2,645	3,042	3,498	4,023	4,425	4,867	5,354	5,890	6,479
CO ₂	500	575	662	760	875	1,006	1,106	1,217	1,339	1,472	1,620
AFFF	1,000	1,150	1,323	1,521	1,749	2,011	2,212	2,434	2,677	2,945	3,239
Total	12,350	14,203	16,333	18,783	21,600	24,840	27,324	30,057	33,062	36,369	40,005

FIGURE 1-1: DOMESTIC CONSUMPTION FORECAST AS A GRAPH

F. Development of the Halon Phaseout Program



17. **The management structure for halon phaseout.** In order to implement the Protocol, a "Leading Group for Ozone Layer Protection" was established in China, with membership of approximately 20 ministries and commissions. NEPA and MPS are the supervisory and regulatory agencies, respectively, for halon phaseout. NEPA is responsible for the daily management of ODS phaseout. MPS has set up "The Leading Group for Halon Conversion for China's Fire Protection Sector," and is responsible for the organization and implementation of halon phaseout.

18. **Implementation of halon phaseout.** China has already introduced a range of measures related to the fire protection industry and for the use and control of agents used in the industry. The proposed sector plan builds on action already taken by to control halon 1211 production,

including a freeze on the setting up of new halon producers and shutdown of nine existing halon 1211 production facilities. Halon phaseout policies to date have included:

- (a) In 1990, MPS, the Ministry of Electronic Industry, and the Industrial and Commercial Administration jointly issued a "*Circular on a Temporary Halt to the Establishment of New Production Sites for Fire Extinguishers, Fire Extinguishing Agents, and Fire Engines*";
- (b) In 1991, MPS introduced a production permit system for halon agent and halon extinguishers and issued a circular stipulating that applications to establish new enterprises for halon agent production and halon servicing enterprises would not be approved;
- (c) On November 11, 1994, MPS and NEPA jointly issued a "*Circular on bans of new installations of halon extinguishers for non-essential use*";
- (d) In 1995, the Fire Protection Agency under MPS issued a "*Circular on Implementing the 'Circular on bans of new installations of halon extinguisher for non essential use'* "; and
- (e) In July 1996, MPS issued a "*Circular for Promoting the Application of Halon Substitutes.*"
- (f) In addition, several national level publicity conferences have been held in Fujian, Guangdong, Zhejiang, Liaoning and other provinces.

19. These policies are intended to accelerate halon phaseout in China in advance of Montreal Protocol controls. The impact of these policies on future halon growth and possible reductions is expected to relate directly to availability of MLF technical and financial support for phaseout. To date, these policies have resulted in actual halon phaseout due to MLF support for an ABC powder plant, conversion of two large halon extinguishing facilities, and the closure of Tongxiang for which the MLF provided compensation for labor displacement. In fact, the phaseout achieved through these MLF supported projects is expected to have allowed China to freeze halon consumption in 1996 to 1995 levels of production. However, additional support would be needed to prevent future growth and complete halon phaseout ahead of Montreal Protocol controls.

20. Table 7-1 summarizes the funding for and impact of the fourteen halon phaseout projects in China which have received MLF support (excludes \$730,000 portion of Tongxiang closure which was canceled). Further to these actions, China has supported the closure of eight halon agent producers and nine halon extinguisher manufacturers. The total cost to China of these closures is estimated to be US\$ 6.5 million.

TABLE 1-7: PREVIOUSLY APPROVED MLF PROJECTS FOR THE HALON SECTOR IN CHINA

	ODP to be phased-out*	Fund allocation
Investment projects:		
Halon fire extinguisher conversion:	2,980 MT ODP	US \$ 1,241,000
Production closure/substitute (not included in total below)	(1,200 MT ODP)	US \$ 1,005,000
Recovering and recycling projects:	200 MT ODP	US \$ 1,161,000
Technical assistance/demonstration:		US \$ 762,000
Project Preparation (excluding \$350 for sector approach):		US \$ 200,000
Total	3,180 MT ODP	US \$ 4,369,000

* The ODP for halon 1211 is 3.0

21. Total phaseout cost of halon sector actions to date are summarized below:

China-funded closure actions ⁶	US\$6,500,000
MLF funded actions	US\$4,369,000
China-funded portion of Tongxiang Project	US\$ 730,000
Total (rounded)	\$11,600,000

22. According to demand projections based on 15 percent growth, domestic consumption of halon 1211 should grow by about 1,490 MT (4,480 MT ODP) between 1995 and 1996. However, as can be seen from Table 1-7, this expected growth, should not have materialized due to phaseout efforts supported in part by the MLF. The sector plan avoids double-counting phaseout already achieved with fund support by limiting funding requests to the 1995 baseline consumption and production levels and by starting to cost the phaseout program from 1997 (costs to date are treated as "sunk costs" and excluded from calculations of future costs). In other words, the phaseout needed to maintain 1996 levels at 1995 baseline is not costed in the sector plan since the MLF has already supported a portion of those phaseout costs.⁷

⁶ Based on an aggregate cost estimate of \$2/kg halon (\$0.66/kg ODP) for the closures of the eight halon production and nine halon extinguisher enterprises described in paras 8 and 9 and assuming that production would have increased to 13,200 tons in 1997 if no action had been taken. Actual costs of these closures have not been calculated.

⁷ As halon growth would otherwise continue, China will incur additional incremental costs for every year beyond 1996 for which the 1995 baseline is maintained.

G. Phaseout Strategy for Halon in the Extinguisher Sector

23. The phaseout strategy has been established on the basis of review and analysis as well as the forecast for extinguishing agent, extinguishers and system's production and consumption.

24. **Strategic Objective for Phaseout.** In accordance with the provisions of the Montreal Protocol and the Country Program, the Chinese government has determined that the fire protection sector will phase out halon 1211 production by December 31, 2005, and phase out halon 1301 production (which constitutes about 5 percent of total production) by January 1, 2010. By 2002, halon 1211 production would be reduced to 1,990 tons to cover the demand for servicing and refilling of existing equipment only.

25. **Phaseout Process and schedule.** Since halon possesses large ODP values, the Chinese government has, based on cost analysis presented in chapter three, decided to phase out production and consumption within the shortest feasible period of time as this will result in the lowest unit cost of halon phaseout. The plan is to reduce halon 1211 production and consumption by 50 percent within 30 months (by 1999), reduce an additional 30 percent by 2002, and then complete phaseout by Jan 1, 2006. Halon 1301 production and consumption would be frozen at 1995 levels and then phased out beginning in the year 2001. (Details of halon phaseout schedule and action plan are found in chapter 4.)

26. Principles for Selecting Alternative Technologies and Substitutes

- (a) Selected halon substitute technologies and substitutes must not be harmful to the ozone layer and have an equivalent fire extinguishing capacity;
- (b) Quality of substitutes must meet safety requirements for fire protection;
- (c) Production of substitutes must meet Chinese demands for clean and general extinguishing agents;
- (d) Need to balance extinguishing agent substitutes with market demand based on extinguishing properties.

27. **Alternatives.** Based on China's situation, halon will be kept in essential uses until substitutes that are equal to halon are developed. Based on the selection principles noted above, alternative agents to replace halon in non-essential will be selected from:

- (a) ABC powder, CO₂ and AFFF for new fire extinguishers; and
- (b) CO₂, FM 200, FE 13, NAF 3s, Inergen, Argonite, and possibly water mist for new fire protection systems (until more suitable alternatives are available).

28. **Ratio of Alternatives.** According to the projections of market demands for extinguishers and information from the extinguisher manufacturers, the Chinese government has concluded that

clean agent extinguishers will account for 15 percent of the total extinguisher market as halon 1211 is phased out. (Halon 1211, a clean agent, currently comprises 22% of the extinguisher market.). As a percentage of the total fire extinguisher market, 15 percent clean agent is consistent with Europe and the USA market demand. The MFEC also indicated its support for a post-conversion ratio in the fire extinguisher sector of 85 to 15 percent at its 18th Meeting (Decision 18/4).

H. Phaseout Measures

29. In order to bring about the phaseout of halon 1211 and halon 1301 under this sector plan, China would adopt the following measures:

- (a) Enterprises producing halon 1211 and the halon 1301 manufacturer will be closed in line with the phaseout schedule;
- (b) Manufacturers of halon extinguishers will be converted to the production of non-halon extinguishers⁸;
- (c) Manufacturers of halon 1211 and 1301 extinguishing systems will be converted to the production of non-halon systems;
- (d) Service stations for extinguishers will be equipped to service and refill ABC powder, CO₂ and AFFF fire extinguishers.
- (e) Halon extinguisher service stations will be equipped with recovering and recycling equipment to limit emissions during servicing and to capture halon from retired extinguishers.
- (f) A halon bank will be established to meet demands for essential uses of halon as production is phased out;
- (g) Enterprises for producing substitutes for halon 1211 and 1301 in sufficient quantities to satisfy market demands will be established and substitutes will be promoted;
- (h) Campaigns will be organized to promote the halon phaseout program and the need for production and use of alternative agents;
- (i) Technical standards and codes will be designed for substitutes, particularly to develop a system of quality control;
- (j) Policies and regulations to support the phaseout plan will be designed and introduced; and

⁸ Of the 83 halon extinguisher manufacturers, nine have been shut down as part of China's halon phaseout strategy. The sector plan, thus, only covers the remaining 72 plants which will be converted to production of substitute using extinguishers.

- (k) An effective monitoring and enforcement system including a management information system (MIS) will be introduced to ensure the achievement of the phaseout plan.

II. CHINA'S POLICIES FOR HALON PHASEOUT IN ITS FIRE EXTINGUISHING SECTOR

A. Necessity for China to Implement Policies For the Halon Phaseout

1. Because of the campaign launched by China's government for ozone layer protection and also the implementation of projects supported by MLF, producers of halon agent and halon fire equipment acknowledge that halon is to be phased out. However, there exist obstacles to the phaseout process, including: consumer preference for halon-based fire protection equipment; the profitability of halon agent and extinguisher production; the costs of closing halon production lines including labor displacement costs, dismantling equipment and investing in substitutes that currently display lower profitability and consumer resistance; and the need of many existing enterprises for capital investments and technical assistance for conversion. Thus, in addition to financial support from MLF, achievement of the phaseout requires government policies that alter final consumers' and enterprises' incentives; transfer of technology for suitable substitutes and alternatives; training and re-deployment of workers; and technical assistance.

B. Policy Objectives

2. According to the Country Program, the general objectives of policies that support and promote the phaseout of halon are: to establish an integrated policy system to provide effective support for China's halon phaseout process; to ensure total phaseout of the production of halon 1211 in China by 2005 and halon 1301 by 2010; to promote and ensure production of alternatives and substitutes to meet the rapidly growing demand for fire protection; and to ensure the safety of fire protection systems in China.

3. Because the program for halon phaseout links production and consumption, the specific policy objectives under this sector plan are as follows:

- (a) To limit the demand for halon extinguishers and system by extending and enforcing bans on new installations for non-essential uses and thereby to control and reverse trends in increased consumption of halon. This policy seeks to reduce halon production by constraining the market for halon based extinguishers and systems;
- (b) To limit and control production and supply of halon agent and to manage imports and exports of halon. This policy seeks to control directly the production of halon agents and to reduce the supply of halon available to producers of extinguishers and systems;
- (c) To increase the demand for halon alternatives and substitutes by encouraging production and use of halon alternatives and substitutes, improving their quality, and altering consumer preferences;

- (d) To control production of halon extinguishers and systems by encouraging conversion of halon extinguisher and system enterprises; and
- (e) To establish halon banks to ensure that demands for essential uses of halon are met after the phaseout of halon production, and to destroy and dispose of halon through the adoption of appropriate technology.

C. Policy Framework and Enforcement Mechanism Design

4. Principles for Policy Design. The basic principles are:

- (a) To be consistent with the characteristics of the halon sector in China and the nature of recent reforms of the economic system, including the modifications of enterprises behavior within the context of a transition from a planned to market economy;
- (b) To ensure the practicality and feasibility of implementing policy instruments and possibility of monitoring and management;
- (c) To learn from the experiences of other countries; and
- (d) To create a balance between economic efficiency and equity.

5. Policy Framework. Based on the above objectives and principles, China will introduce additional policy instruments to ensure the achievement of a cost-effective halon phaseout. The policy instruments designed include command and control measures, as well as economic incentives and voluntary agreements.

6. The policy package which will be introduced through this sector plan has, as its central pillars, the control of production and supply of halon agents on the one hand, and the conversion of enterprises producing halon extinguishers and systems on the other. From the point of view of policy control, both control of halon demand and supply are required to achieve cost-effective halon phaseout and maintenance of fire protection.

7. Supply-side Policy. A permit and tradable production quota system is the key instrument in the policy framework that will be adopted upon approval of this sector plan. It will reduce the uncertainty for implementing the halon phaseout strategy. The quota system will be complemented by availability of grants that will encourage enterprises to phase out through a bidding scheme.

8. Demand-side Policy. The major instrument will be bans on new installations of halon extinguishers for non-essential uses and periodic modification of the definition of non-essential areas. As noted in chapter 1, a circular banning new installations of halon in non-essential uses took effect in 1995. However, its effectiveness will depend on aggressive enforcement. This sector plan, when approved by the MFEC, is expected to provide sufficient compensation to affected enterprises making possible more rigorous enforcement of the non-essential use bans. In

this way, the scope of the market for halon-based fire protection will be narrowed.

9. Public education and related training and technical assistance are important supporting instruments for control of halon production and consumption. Therefore, implementation of all policies adopted as part of this sector plan will include design and implementation of public education and training programs.

10. China's policy framework for ensuring halon phaseout is summarized in Table 2-1 on the following page. (This timetable is based on prompt financial assistance from MLF beginning in 1997. Delays in financial assistance would delay the program.)

D. Description of Policy Instruments

11. **Ban on New Installations of Halon Extinguishers for Non-Essential Uses and Its Adjustment over Time.** On November 11, 1994, MPS and NEPA jointly issued a "Circular on New Installations of Halon Extinguisher for Non-Essential Uses." This circular identifies three general categories with 51 specific areas of non-essential use. The circular introduces the following restrictions: (a) all new installations of halon extinguishers are forbidden for non-essential areas; (b) enterprises without a permit are not allowed to produce halon agent and halon extinguishers; and (c) local fire protection monitoring agencies have no right to process applications for production permits for halon agent and extinguishers. It also calls attention to the need for producing and using halon substitutes. This circular took effect on October 1, 1995. On October 12, 1995, MPS also issued a "Note for Implementing the Circular on New Installations of Halon Extinguishers for Non-Essential Use."

12. This policy is monitored and supervised jointly by MPS and NEPA, and local (provincial level) Fire Fighting Agencies and Environmental Protection Bureaus are involved in the monitoring system.

Table 2-1. Policy Framework for Halon Sector Phaseout

Objective	Policy	Timetable for introduction	Timetable for implementation	Responsible agency
Limiting consumption of halon products	1. Bans on new installations for halon extinguishers for non-essential uses	Nov. 11, 1994	Oct. 1, 1995 definition of non-essential use to be tightened every 3 years	MPS NEPA
	2. Management for halon extinguisher servicing enterprises	Dec. 1996	Jun. 1997	MPS NEPA
	3. Revision of fire protection codes for buildings			MPS MOC
	* Fire protection code for design of tall buildings	Dec. 1996	Dec. 1996	
	* Fire protection code for design of buildings	Jan. 1997	Jun. 1997	
	* Code for fire extinguishers in design of buildings	Jan. 1998	Jan. 1998	
	* Fire protection code in underground engineering	Jan. 1998	Jan. 1998	
Controlling Production and supply of halon agents	4. Production permit system for halon agent producers	1991	1991	MPS NTSA
	5. Tradable production quota system for halon agent producers	Sep. 1997	Sep. 1997	MPS NEPA
	6. Bans on halon agent production			SETC
	* Halon 1211	Dec. 2003	Dec. 31, 2005	MPS
	* Halon 1301	Jan. 2008	Jan. 1, 2010	NEPA
	7. Regulations on import and export of halon agents	Jun. 1997	Dec. 1997	MPS NEPA Customs
				MPS
Increasing demand for Halon substitutes and alternatives	8. Technical supervision for halon alternatives and substitutes: revising the technical standards for ABC dry powder	1997	1998	
	9. Circular on promoting the application of halon alternatives	July 5, 1996	July 5, 1996	MPS
	10. Policies for encouraging production of alternatives and substitutes for halon agents and extinguishers	n.a.	n.a.	MPS NEPA
Controlling Production of halon	11. Policies for encouraging conversion of halon extinguisher and system enterprises	n.a.	n.a.	MPS NEPA
Extinguisher and systems	12. Introduction of production permit system for halon extinguishers and systems	1991	1991	MPS NTSA
	13. Ban on production of halon extinguishers and systems			SETC MPS
	* Halon 1211	2003	Dec. 31, 2005	NEPA
	* Halon 1301	2008	Jan. 1, 2010	
Halon Banking and halon destruction	14. Management of halon banking	Dec. 2000	Jun 2001	MPS NEPA
	15. Management of halon destruction	Jan 2005	Jan 2005	MPS NEPA

Note: MPS: Ministry of Public Security; NEPA: National Environmental Protection Agency; MOC: Ministry of Construction; SETC: State Economy and Trade Commission; NTSA: National Technical Supervision Administration

13. Effective July 5, 1996, an administrative circular was issued by the Fire Fighting Department of MPS defining a new policy. The characteristics of this policy are:

- (a) Main alternatives for halon are CO₂, AFFF and ABC powder in 'non-essential uses';
- (b) Production permit system for ABC powder is proposed to be effective in 1997 in order to promote improvements in ABC quality. Production permits will be issued only after certification by MPS agency of satisfactory production processes and product quality;
- (c) Quality of ABC powder will be assessed as a basis for issuing production permits for new and existing producers; and
- (d) Use of fire fighting systems should follow the various fire fighting codes.

14. The definition of non-essential uses will be more narrowly defined in 1999, 2002, and 2005, respectively, in order to reduce the scope of the market and thereby the demand for halon extinguishers.

15. These policies are potentially effective instruments for controlling halon consumption, and send a signal to producers of halon concerning future market size and development. For these command-and-control instruments, strong enforcement is critical to their success. Enthusiasm for proactive enforcement of halon reduction policies in advance of Montreal Protocol controls is expected to depend on the availability of technical and financial assistance to halon producers and extinguisher and systems manufacturers.

16. **Following approval of this sector plan**, the Chinese government would enhance enforcement efforts by:

- (a) Promoting awareness of users about the bans through various channels (TV, newspapers and other media, specific campaigns and training);
- (b) Requiring users of extinguishers (chiefly in the non-essential use areas) to report to fire fighting agencies the name, type and size of extinguishers and the premises protected. Local fire fighting agencies and environmental protection bureaus are responsible for monitoring users and for requiring users to replace halon extinguishers used in non-essential areas to adopt alternatives within a specific period; and
- (c) Requiring local fire fighting agencies and environmental protection bureaus to report to MPS and NEPA concerning extent of enforcement and measures adopted to ensure compliance with the policy.

E. Management for Halon Extinguisher Servicing Enterprises

17. Halon extinguisher servicing enterprises are responsible for servicing the existing stock of extinguishers. Bilateral assistance from the MLF through US EPA has helped to demonstrate the feasibility of halon recycling during extinguisher servicing. As part of this sector strategy, MPS will require servicing enterprises to hold a servicing permit and have appropriate recovery and refilling equipment installed to minimize emissions during servicing and allow for halon recovery from retired extinguishers.

F. Revising the Codes for Fire Protection of Buildings

18. The four major codes concerning uses of halon extinguisher and system are the "Code for Fire Protection Design of Tall Buildings" (which covers civil works), "Code for Fire Protection Design of Buildings," "Code for Fire Extinguishers Allocation Design of Buildings," and "Code for Fire Protection Design of Underground Structures." As part of this sector plan, these codes will be promptly revised chiefly in areas related to installation of Halon 1211 and Halon 1301 extinguishers and systems and their suitable substitutes. The related fire protection code issued at ministry and department levels would be changed accordingly after these four major codes have been revised.

19. The revision of these codes is expected to reduce the demand for halon extinguishers (and thus the demand for halon agent). Implementation and enforcement of the codes will be done within the framework of existing regulations governing the implementation and enforcement of codes.

G. Production Permit System for Halon Agents

20. In 1991, MPS and the Technical Supervision Administration jointly introduced a permit system for halon agent production, and stipulated that new enterprises for halon agent production and servicing would not be approved, while existing capacities should not be expanded. Due to insufficient baseline information about halon manufacturers at that time, capacity expansion has been difficult to monitor. While the number of halon agent producers has been limited through the permit system, more recent surveys by MPS and World Bank technical experts indicate that manufacturers' capacity increased between 1991 and 1995 mainly due to technical process improvements. MPS estimates that current production capacity for halon 1211 is 17,800 MT.

21. Nonetheless, the permit system has been an important instrument for improving sector management and ensuring product quality. Enterprises that do not have a valid permit are not allowed to produce halon agent. Production without a permit is punishable within the framework of China's general regulations on industrial production permits.

H. Tradable Production Quota System for Halon Agents

22. The production quota system, which will be adopted upon approval of this sector plan, combined with the existing production permit system is the key policy element for implementing the halon phaseout strategy. Since China is moving toward a market-based economic system, enterprises will be allowed to trade their quotas, so that they are encouraged to implement a

phaseout program while reducing the costs of phaseout. The major contents of the quota system can be summarized as following:

- (a) In accordance with regulation jointly published by NEPA, MPS and the Ministry of Chemical Industry, NEPA will issue production quotas for each year to those enterprises holding a permit for halon production;
- (b) The relative size of the quota in the first year of operation of the quota system will be based on the structure and level of declared production in 1995 (not to exceed 9,950 for halon 1211 and 750 for halon 1301). The quota will be reissued each year and reduced in accordance with the overall phaseout plan;
- (c) Producers of halon will not be allowed to exceed the allocated yearly production quota;
- (d) Enterprises with a permit can trade their quota either for that year, or as a permanent trade. Enterprises that trade their quotas must report trades to NEPA who will reallocate quota accordingly; and
- (e) Based on the outcome of grant bid scheme, enterprises participating in the bid which have been selected to sell back their quota to the government would sign a contract to dismantle their halon production facilities. After the contract is in effect, the production quota and production permit would be taken back.

23. Monitoring and enforcement mechanism for the quota system is expected to be:

- (a) Enterprises holding a quota must report halon production figures to NEPA who will inform MPS, the local EPB and fire fighting agencies;
- (b) Local EPBs and fire fighting agencies would from time to time check production information and visit enterprises to confirm data submitted, and report to NEPA and MPS on the monitoring activities as well as the data;
- (c) NEPA and MPS will monitor and supervise implementation of the quota system;
- (d) Any enterprise giving false information will be warned and fined;
- (e) Any enterprise that fails to report or delays its report will be fined;
- (f) Any enterprise whose production exceeds the quota will be fined and its production will be sealed off; and
- (g) Any enterprise producing halon without a quota will be fined, its production will be closed off by the local government.

I. Grants for Halon Agent Producers Awarded By Competitive Bidding System

24. Under this sector plan, halon agent producers would have an opportunity once a year to sell back their production quota to the government through a competitive bidding process. Manufacturers would submit bids -- offers to sell their halon quota -- for a specific unit price (Yuan/kg halon). The government would evaluate bids and award grants to those with the lowest offer price based on the amount of grant available for production closure in that year. Provided the government is able to buy back sufficient quota through the bid, the remaining halon producers would retain their quota at the same level in the next year. However, if the level of quota purchased through the bid is less than the targeted phaseout amount, quota reductions would be made pro rata among firms which were unsuccessful, or did not participate in the bid.

J. Bans on Halon Agent Production

25. Following approval of this sector plan, the government will announce publicly the phaseout program. An official ban on halon 1211 and 1301 production will be issued in 2003 and 2008, respectively.

K. Regulations on Import and Export of Halon Agent

26. China is planning to list halon agents on the 'List of Toxic Chemicals Which are Banned or Strictly Restricted in China', and will regulate them according to the 'Regulations for Import and Export Environmental Management of Toxic Chemicals and First Time Imports of Chemicals,' which was issued by NEPA in March 1994 and took effect on May 1, 1994.

L. Technical Supervision for Halon Alternatives and Substitutes

27. The technical standard for ABC dry powder will be revised in order to improve the quality of halon alternatives available, since ABC powder extinguishers will be a major alternative for halon extinguishers installed in buildings. The implementation of technical standards of ABC powder will be regulated within the context of general regulations concerning technical standards of China.

M. Circular on Promoting the Application of Halon Alternatives

28. On July 5, 1996, MPS issued the 'Circular on Promoting the Application of Halon Alternatives.' The major contents of this circular are:

- (a) The alternatives for halon 1211 extinguisher are: ABC, CO₂, and AFFF;
- (b) In order to improve the quality of ABC dry powder, MPS will issue a production permit to enterprises producing ABC agent and extinguishers. The production permit will include a standard requirement for MAP in the ABC powder, which should be 50 percent and 70 percent;
- (c) To reflect the principle that higher quality justifies a higher price, and to inform users about MAP content and benefits, ABC dry powder extinguisher enterprises

should include MAP content on the label for their products; and

- (d) Areas that are allowed to use halon extinguishing systems should follow strictly the Code for Fire Protection Design of High-rise Buildings (civil works), Code for Fire Protection Design of Buildings, and other related codes and regulations, and should not expand the application area of halon systems. For those areas that should make use of a gaseous system, CO₂ and inert gaseous systems are recommended, while HFC-based systems like FM 200 are permitted.

29. The implementation of this policy will promote the production of halon alternatives and, therefore, speed up the halon phaseout process in China.

N. Encouraging Production of Alternatives and Substitutes for Halon Agents and Extinguishers and Conversion of Halon Extinguisher and System Enterprises

30. The government will carry out a study on how to make effective use of multiple funding sources (including the MLF funds) to encourage production of alternatives and substitutes for halon agents. Such incentives would have the characteristics of investment subsidies, with a view to provide an incentive for investment in the production of halon alternatives and substitutes. Conversions of halon extinguisher and system manufacturers will be supported through grants made available through an annual bidding process. As manufacturers will have to compete for grants, it is expected that they will pursue appropriate least cost conversion options and will time phaseout so as to minimize conversion costs.

O. Production Permit System for Halon Extinguishers

31. In 1991, MPS implemented a production permit system for halon extinguishers, and stipulated that new enterprises for halon extinguisher production and servicing would not be approved. However, high profits in the halon sector led to development of over-capacity among halon extinguisher producers. Nine halon extinguisher enterprises were recently shut down by the government to consolidate production as part of China's halon phaseout strategy.

32. The permit system is an important instrument for improving sector management and ensuring quality production. Production without a permit is penalized in accordance with China's general rules on industrial production permits.

P. Bans on Production of Halon Extinguishers and System

33. Following approval of this sector strategy, the government will announce publicly the phaseout program. An official ban on halon 1211 and 1301 extinguishers production will be issued in 2003 and 2008, respectively.

Q. Management of Halon During Servicing and From Retired Extinguishers/Systems

34. To meet demands of essential use of halon and ensure fire fighting protection in specific areas, the government plans to expand halon recycling practices to all registered extinguisher service shops and to set up a halon banking system including recovery and reclamation of halon

from retired extinguishers and systems.

R. Management of Halon Destruction

35. To avoid emission of halon 1211 that is recovered from extinguishers, but contaminated, MPS and NEPA will conduct investigations to design ways of ensuring appropriate disposal and destruction of halon.

III. INCREMENTAL COST ANALYSIS FOR PHASEOUT OF HALON IN CHINA

A. Introduction

1. This chapter discusses the incremental costs of phasing out halon in China and explains the results of calculations done with a computer-based model. The model was developed to provide a basis for choosing the most cost-efficient phaseout profile for China and to determine both the total incremental costs to the Chinese economy and the eligible incremental costs for which funding is being requested. Annual grant funding requests to meet specific phaseout targets are given in chapter four. Assumptions, model inputs and the calculation methodology are found in Annex 1 to this chapter.

The cost model has five major facets:

- (a) To calculate, on the basis of various assumptions and data, the incremental costs (measured in constant dollars) for the Chinese economy and those costs eligible for funding from the Multilateral Fund of various phaseout options (scenarios), with the costs expressed in terms of both annual costs over the phaseout period and also NPV;
- (b) To calculate the amount of halon production "savings" (overall halon consumption avoided) under each scenario, compared to the alternative of continuing to produce and consume halon in compliance with the provisions of the London Amendment of the Montreal Protocol;
- (c) To rank different phaseout scenarios in terms of total cost, eligible incremental cost and cost per kilogram of "saved" halon;
- (d) To provide a basis for selecting the recommended phaseout plan, taking cost, uncertainty associated with those costs, and halon saved into consideration; and
- (e) To compare the funding request for this sector plan to a project-by-project scenario.

B. Scope of Cost Analysis

2. Two costs of phasing out Halon 1211 and 1301 in China are analyzed within the model: the total economic incremental cost to China (TEIC), and the eligible economic incremental cost from MLF under its current rules (EEIC). For measuring, double-counting has been avoided and the methodology identifies costs where they first arise, thereby ignoring the fact that additional costs in the manufacturing sector would normally be passed on to consumers of the product in the form of higher prices.

C. The Modeling Process

3. The modeling process comprised five steps:

- a) The factors that influence the incremental costs associated with a complete phaseout of halon were identified.
- b) A demand projection for fire protection in China until 2010 was developed, showing the allocation of fire fighting agents to new extinguisher and systems production and to servicing of existing stock over time.
- c) Phaseout scenarios were developed, setting up both the date for total phaseout and the profile for phaseout.
- d) Based on the phaseout profile and the amount of halon agent production to be reduced annually, the model calculated the production of substitute agent and extinguishers and systems required to replace the halon-based production removed from the market and calculated the allocation of remaining halon to new production and servicing, while estimating the need for recycling and recovery of halon to build a halon bank.
- e) Based on the incremental cost categories developed for each element of the phaseout program, the model calculated the incremental costs to China and the eligible incremental costs from the MLF.

D. Factors Influencing Incremental Cost of Halon Phaseout in China

4. There are numerous factors that will influence the incremental costs of halon phaseout, including: phaseout schedule; the overall level and structure of demand for fire protection; the conversion rate from halon fire extinguishers and systems to substitutes; substitute selection; the extent of halon recovery, recycling and destruction; and the size and sources of halon banking. Some of the incremental costs to halon phaseout can be estimated with a high degree of certainty. These include costs of premature retirement of halon production plants and the costs of converting halon extinguisher manufacturers to well established substitutes. However, other costs are less well known. The costs of avoiding premature retirement of installed halon equipment through halon recovery and banking are perhaps the least well understood.

Growth Rate

5. As discussed in Chapter 1, the demand for fire protection is likely to continue to grow at least as quickly as the growth rate of the economy. The EEIC, is insensitive to changes in the overall growth rate of the market for fire protection. This is because the model assumes in all scenarios that halon production is capped at the 1995 production level. The significance of the continued high growth rate for the halon phaseout is linked to fact that a high rate of growth in the fire protection market requires a large amount of financial resources, and a phaseout program imposes further costs on the industry.

Fire Extinguisher Market Structure

6. The overall growth rate of the fire protection industry is not the determining factor in halon phaseout costs. It is the structure of the fire extinguisher market, and in particular, the share of the market requiring clean extinguishers that affects the nature of the halon phaseout, and thus the costs of replacement and conversion. Since halon 1211 alternatives differ in terms of price and physical properties and fire fighting capacities (none of the alternatives is equivalent to halon), different choices of alternatives affect the ability of the fire equipment sector to meet fire protection needs and the incremental capital and operating costs associated with conversion to those alternatives. So while the costs of conversion may be estimated with a high degree of certainty, the costs are very sensitive to the choice of technology.

7. Analysis of the Chinese market suggests that approximately 15 percent of the overall market demand for extinguishers will be for clean agent. Consequently, in order to produce this market structure after halon phaseout, the model shows that the conversion rate from halon extinguisher production should be 31 percent to ABC; 65 percent to CO₂; and four percent to AFFF.

Fire System Market Structure

8. To eliminate the use of halons in new fire protection systems, market structure is less of a factor in determining incremental costs. Alternatives for halon 1301 systems vary in physical properties and fire fighting/suppressing capabilities (again none of the alternatives is equivalent to halon), but the substitutes are more comparable in price -- when installed costs of systems are compared -- than those that will be adopted for halon 1211 in fire extinguishers. Thus, while there is still uncertainty about which substitutes will ultimately be selected by Chinese fire system manufacturers, the incremental costs of phaseout appear to be relatively insensitive to this choice.

Speed of Phaseout

9. Overall incremental costs are influenced as much by the profile of substitute selection for fire extinguishers as by the speed of phaseout. The faster the phaseout, the higher the incremental costs for closure of halon agent producers, due to the higher cost of premature retirement for the closed factories. In addition, the economy faces an economic cost related to the advancement of replacement investments. For example, if the phaseout results in halon plants closing in 2005 instead of continuing to the end of their life of 2010, the economy has to incur costs of investing in a replacement at an earlier date.

10. However, the faster the phaseout, the lower the incremental costs for halon recovery, reclamation, and banking which are needed to avoid even higher costs of premature retirement of newly installed halon equipment (systems and extinguishers). A faster phaseout requires the economy to start incurring costs under these categories at an earlier date, but the overall costs are likely to be less under a faster phaseout because the stock of halon equipment that will be needed to make use of these relatively expensive activities for assuring a supply of halon after phaseout

will be smaller. In principle, the alternative to recycling and banking would be to import halon, but this is not a realistic scenario for China, given the scale of needs relative to probable world supply of halon after China's proposed phaseout.

Halon Recovery, Reclamation and Banking

11. The potentially high costs of premature retirement of halon equipment would lead to a clear decision to cease as soon as feasible the manufacture of new halon systems and extinguishers as a means to reducing overall halon phaseout costs. Halon recovery, reclamation, and banking from retired units provide a means to offset the costs of premature retirement. However, the degree to which costs of premature retirement may be offset through recovery and banking is not well known, and may be sensitive to factors which have been excluded from this analysis. In one industrialized country, for example, the government pays \$16/kg to bank halon 1301 (more than double the price of newly produced halon in China). Due to the high degree of uncertainty and comparisons to costs reported by industrialized countries, the costs for halon recovery, recycling, reclamation and banking are easily underestimated (whereas the costs associated with production closure and extinguisher/system production conversion are much better known.) Thus, opting for a delayed phaseout schedule would shift to China a high risk that incremental costs would greatly exceed estimates.

Ozone Protection

12. Finally, there is the major issue of ozone protection. Obviously, the longer phaseout is delayed, the greater the build-up of halon that will ultimately be emitted and contribute to ozone depletion. So, while the costs of a later phaseout may be less in absolute terms (comparing NPV of costs), this would ignore the environmental benefits of earlier phaseout. A more accurate way of considering this tradeoff would be to consider the unit cost of saved halon against some baseline. In this case, the Montreal Protocol phaseout schedule was used as to compare the total amount of halon phased out under various phaseout schedules.

E. Design of Phaseout Scenarios

13. Seven scenarios for phasing out halon 1211 production, and one scenario for halon 1301 were developed for more intensive analysis within the cost model. The seven scenarios provide variations in three parameters: phaseout speed and profile, alternative technologies and substitutes, and halon banking (see Table 3-1).

TABLE 3-1: HALON 1211 PHASEOUT SCENARIOS

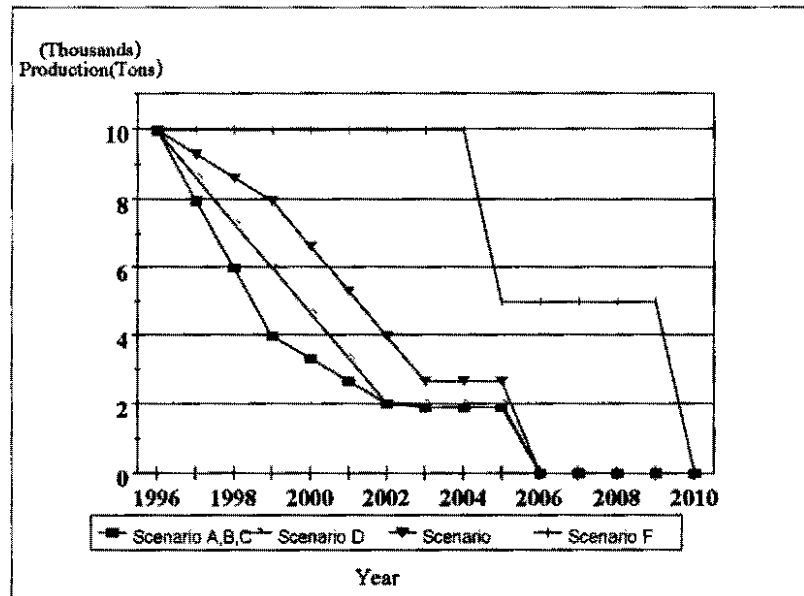
	1997-1999	2000-2002	2003-2005	2006	Alternative Agent for extinguisher	Halon bank
Scenario A	50%	30%	0%	20%	HCFC	Yes
Scenario B	50%	30%	0%	20%	ABC, C _o 2, AFFF	Yes
Scenario C	50%	30%	20%	0	ABC, C _o 2, AFFF	No
Scenario D	36.7%	40%	0%	23.3%	ABC, C _o 2, AFFF	Yes
Scenario E	20%	40%	13.3%	26.7%	ABC, C _o 2, AFFF	Yes
Scenario F	Baseline MP limits with growth after 1995				ABC, C _o 2, AFFF	Yes

Note: Baseline from which percentage reductions are made is 9,950 MT halon 1211 (1995 production level). Steady production in 2003-05 is needed to build a bank for servicing of extinguishers/systems until 2010.

14. Scenario 'F' is defined here as the baseline scenario for reference. Its halon 1211 phaseout schedule is in conformity with that of the London Amendment of the Montreal Protocol; that is, halon production increases to meet basic domestic needs (15 % annually until 2000 and then 10%) until 2002, in 2002 production is reduced to the average production of 1995 - 1997, in 2005 halon production is 50 percent of the 2002 level, and complete phaseout is achieved in 2010. Such a scenario would generate large phaseout costs to China, and eligible incremental costs from the MLF would also be high. An additional reference scenario for comparisons to project-by-project approach is being developed.

15. Scenarios 'A', 'B' and 'C' estimate the costs of adopting different approaches to phasing out halon 1211 by 2006 on a phaseout profile of 50/30/20 (Scenario C phases out more rapidly as no extra production is done to create a bank). As scenario 'B' is the least cost among these options,⁹ the question becomes one of choice between Scenarios 'B', 'D' and 'E', which measure the costs of different time frames for phaseout by the end of 2006. Scenario 'B' front loads the phaseout, Scenario 'E' back loads the phaseout, and 'D' is in between.

Figure 3-2: The Phaseout Schedule of Halon 1211



16. A single scenario has been defined for phaseout of halon 1301 (See Table 3-3). Halon 1301 production is frozen at 1995 levels, and it is assumed that newly produced halon will mainly

⁹ Scenario A assumes conversion of halon extinguishers to HCFC, generating (because of its high costs) huge costs for China and somewhat higher costs than scenarios B and C for the MLF. Scenario C assumes that halon banking would be supplied from imported halon; at current world prices, this option would increase costs to China and to the MLF, compared to scenario B.

be used for servicing and refilling existing installed systems. As such, it is also assumed that all beginning in 2006, all new systems will use halon 1301 substitutes. In order to limit costs of premature retirement for existing systems (alternatives are expensive), the phaseout is rear-end loaded, with most of the production phaseout occurring after 2005. By itself, the proposed phaseout would not meet the provisions of the London Amendments, but is acceptable because an accelerated phaseout of halon 1211 is anticipated.

TABLE 3-2: HALON 1301 PHASEOUT SCENARIO

	1997-2000	2001	2006	2010	substitute	Banked
Phaseout %	0	20	60	20	FM 200 ¹⁰	Yes

* The percentages refer to the phasing out of 750 tons of Halon 1301.

F. Technical Assistance

17. The costs of technical assistance (TA) required to achieve halon phaseout are considered to be independent of the scenarios being evaluated. TA includes such items as policy development and implementation of policy measures, codes, quota systems, public awareness, development of alternate technologies, technical assistance to enterprises and service stations, testing facilities and development of the management information system as a monitoring tool for the entire halon sector phaseout plan.

18. The NPV cost of technical assistance is estimated at \$6.0 million covering the entire phaseout period. These costs will be broken down into components with detailed scope and costs prescribed as part of each annual plan. Chapter 4 includes a detailed breakdown of cash flow requirements for TA over each stage of the phaseout program.

G. Specification of Incremental Costs

19. The incremental costs included in the calculations of TEIC and EEIC are subdivided into eleven cost categories as defined in Table 3-3:

¹⁰ The model uses FM 200 as a proxy for substitute system costs. According to HTOC members, the incremental installed cost of halon substitute systems such as Inergen and CO2 is either more expensive or roughly equivalent to FM 200.

TABLE 3-3: DEFINITIONS OF INCREMENTAL COST CALCULATIONS

Incremental Costs	TEIC	EEIC
1. Premature closure of halon 1211 producers	lost profits and two years labor compensation based on halon 1211 production capacity (17,800 MT) and unconstrained halon demand	lost profits and two years labor compensation based on actual 1995 halon 1211 production (9,950 MT)
2. Conversion of halon 1211 fire extinguisher producers	capital costs and incremental operating cost until 2010	capital costs and six-months incremental operating cost
3. Conversion of halon 1211 system producers	incremental operating costs until 2010	one year incremental operating costs
4. Conversion of halon 1301 system producers	incremental operating costs until 2010	one year incremental operating costs
5. Modification of halon 1211 extinguisher servicing stations to handle new substitutes	capital costs	capital costs for one-third of major service centers
6. Recovery, recycling and reclamation of halon 1211 from extinguishers	capital costs and incremental operating costs/savings until 2010	capital costs and operating costs/savings until 2010
7. Recovery and reclamation of halon 1301	capital costs and incremental operating costs/savings until 2010	capital costs and incremental operating costs/savings until 2010
8. Banking of halon 1211 and halon 1301	capital costs and incremental operating costs until 2010	capital costs and incremental operating costs until 2010
9. Destruction of contaminated halon 1211	incremental operating costs until 2010	incremental operating costs until 2010
10. Plant for halon 1301 substitute	Capital costs	Capital costs
11. Technical assistance and supporting activities	Policy and other support activity (e.g., training, promotion, etc.)	Policy and other support activity (e.g., training, promotion, etc.)

20. The model does not include some of the incremental costs for phasing out halon in China:
- (a) Other incremental costs related to ABC powder substitution in extinguishers; i.e., costs of more frequent refilling, costs of complete refilling and disposal of used ABC powder, higher property damage from ABC (compared to clean agent);
 - (b) Capital costs of converting halon 1211 and 1301 system producers;
 - (c) Capital costs of halon 1211 destruction;
 - (c) Incremental costs of halon 1301 destruction; and
 - (d) Contingencies and unforeseen costs.

H. Analysis of Scenario Costs

21. Table 3-4 summarizes the incremental costs to China and to the MLF under each scenario, and compares the NPV of each scenario's costs to the amount of halon production saved (avoided production and consumption as compared to MP controls).

TABLE 3-4: TEIC, EEIC AND HALON SAVINGS UNDER DIFFERENT SCENARIOS

	TEIC (NPV \$ '000)	EEIC (NPV \$ '000)	Cumulative Avoided Halon 1211 Production/Consumption (MT)*	EEIC of Avoided Halon 1211 Production/Consumption (\$ per kg)
Scenario B	191,190	59,706	99,246	.060
Scenario D	183,327	58,312	93,294	0.63
Scenario E	173,513	54,423	84,339	0.65
Scenario F	172,642	72,914	0	not applicable

* This figure represents the total avoided halon 1221 production/consumption from 1997-2010 as compared to Scenario F -- growth to meet basic domestic needs then phaseout according to MP controls.

22. In Table 3-4, Scenario 'F' is the baseline from which cumulative (as opposed to annual) halon "savings" are measured. Scenario 'F', as previously described, represents the maximum allowable halon production (according to the Montreal Protocol controls for halon in Article 5-1) for countries anticipating growth in halon demand to meet basic domestic needs. Scenario 'B' offers the largest cumulative halon savings because production reductions are high in early years (including the cap in 1996 and 1997). Once halon production is stopped, halon "savings" (avoided halon production/consumption) are considered for each subsequent year as long as those "savings" are above and beyond halon reductions mandated by the Protocol.

23. The interpretation of the results of the model's estimation of the costs of each scenario is fairly straightforward. Summing up the stream of costs (expressed in constant prices) to be incurred over the phaseout period shows that the delayed phaseout results in highest costs (to both China and the MLF) in terms of unit cost of "saved" halon production and consumption. Moreover, when phaseout is delayed and the economy avoids the costs of closure in the early years and defers costs of conversion, the economy faces considerably higher costs in dealing with servicing or retiring on a premature basis a much larger stock of halon-based fire equipment. (The estimates for these costs are, however, based on conservative assumptions and likely underestimate costs China would incur.) When the costs for various phaseout schedules are measured in economic terms and the time value of resources is expressed as a 10 percent discount rate, a slower phaseout represents a lower NPV, and thus economic cost, than a faster phaseout; the economy lowers the economic cost of phaseout by pushing out as far into the future as possible the costs of phaseout. Thus, the faster phaseout, Scenario 'B', has a slightly higher NPV. Likewise, while Scenarios 'D' and 'E' have higher unit costs of "saved" halon, there is also much greater uncertainty associated with their NPV costs as they include a larger proportion of halon recovery, reclamation and banking costs which are not well known.

24. The lower economic costs associated with deferring the phaseout result in higher production of ODS substances over the period. As Table 3-4 shows, the "efficiency" of each scenario can be ranked in terms of the eligible unit costs to the MLF of avoided annual halon 1211 production; Scenario 'B', the accelerated phaseout scenario, is the most efficient in these terms. Scenario 'B' also reduces the risk to China that banking costs have been significantly underestimated.

I. Conclusions

25. Taking into account the results of the modeling exercise and considering the risk of higher costs for halon banking that China may incur if halon phaseout were delayed, the Chinese government has developed its sector plan for halon phaseout based on implementation of Scenario 'B'. The following chapter lays out the action program required to ensure the achievement of such a phaseout.

26. Based on Scenario 'B', total phaseout costs for halon in China are summarized in Table 3-5:

TABLE 3-5: TECI AND EEIC FOR SELECTED HALON SECTOR PHASEOUT SCENARIO

	Total Cost to China (\$ million)	MLF Funding Request (\$ million)
Cost Incurred to date (as of 9/96)	11.6	4.4
Phaseout for Halon 1211	171.0	46.7
Phaseout for Halon 1301	17.7	7.0
<u>Technical Assistance</u>	<u>6.0</u>	<u>6.0</u>
Total	206.3	64.0
<u>Minus costs incurred to date</u>	<u>11.6</u>	<u>4.4</u>
Net Incremental Costs	\$194.7	\$59.7

27. The costs in Table 3-4 and 3-5 are expressed in NPV terms in 1997 dollars. These costs do not represent the amount of funds that will be required over the phaseout period from the MLF. The sum to be paid to China over the period is computed first by reversing the discounting that was done to arrive at the NPV figure (thereby expressing the actual cost in each year in terms of 1997 dollars), and second by taking account of dollar inflation (which could be done by using the World Bank's Unit Value of Manufactured Exports--MUV).

28. A practical example of the implications of these actions is provided below, using the first 2.5 years of the proposed phaseout plan through 1999 (which corresponds to 50% of halon 1211 phaseout).

MLF Funding and Phaseout	1997-1998	1999
	2,985 MT halon 1211 (8,995 MT ODP)	1990 MT halon 1211 (5,970 MT ODP)
	US\$ million	US\$ million
NPV amount	18,884	8,588
PV amount	20,015	10,392
Amount in current dollars ^{1/}	20,288 ^{2/}	10,860

^{1/} Calculated using the World Bank's May 1996 projection for MUV, which estimates dollar inflation of 2.1% in 1998 and 2.3% in 1999. With 1997 = 100, 1998 = 102.1, and 1999 = 104.5.

^{2/} Assumes that 65% of costs would be incurred in 1998.

Technical Annex to Chapter III:
"Incremental Cost Analysis For Phaseout of Halon In China"

I. Key Model Inputs

Production, Export and Stock

Baseline halon 1211 production (1995)	9,950 MT
Export of halon 1211 (1995)	1,400 MT
Stock of halon 1211 extinguisher (1995)	23,023 MT
Stock of halon 1211 systems (1995)	496 MT
Baseline halon 1301 production (1995)	750 MT
Export of halon 1301 (1995)	450 MT
Stock of halon 1301 (halon 1301 imported in systems not included):	760 MT

Halon 1211 Extinguisher Market and Servicing

Major halon 1211 extinguisher service centers	1000
Servicing rate (as a percentage of extinguisher stock)	3.0 %
Basic demand for clean agent fire extinguishers	15.0%

Chemical Prices (in constant 1997 US\$)

Halon 1301 (China)	\$ 8,500/MT
Halon 1211 (China)	\$ 2,706/MT
FM 200 (International)	\$25,000/MT

Capital and Equipment Costs (in constant 1997 US\$)

Capital costs of small 1211 extinguisher enterprise conversion to CO ₂ +ABC	\$ 72,500
Capital costs of medium 1211 extinguisher enterprise conversion to CO ₂ +ABC	\$208,500
Capital costs of large 1211 extinguisher enterprise conversion to CO ₂ +ABC+AFFF	\$286,500
Cost of halon 1211 recycling machine (with compressor)	\$ 6,000/unit
Cost of halon 1211 reclamation equipment	\$20,000/unit
Cost of halon 1301 recycling machine	\$10,000/unit
Cost of halon 1301 reclamation equipment	\$75,000/unit
Capital cost for halon banking (storage capacity)	\$800/MT
Capital cost for new equipment to service ABC, CO ₂ and AFFF (avg.)	\$ 6,000/service center

Growth Assumptions and Discount Rate

Fire protection demand projected growth 1996-2000	15.0 %
Fire protection demand projected growth 2001-2010	10.0 %
Discount rate	10.0%

Explanations Related To Key Model Inputs

1995 halon 1211 and 1301 production and exports: Based on national survey by MPS of all halon 1211 and 1301 producers. All halon production facilities in China were established before

July 1995 and are 100% locally owned. Capacity has not been expanded at any of the plants since July 1995. According to survey data collected from the enterprises, newly produced halon exports in 1995 were being made to only Article 5 countries in South America, SE Asia, and the Middle East.

Future halon exports: Export of halon 1211 is assumed to decline by 200 MT/yr from 1997 to 2002 and remain at 100 MT/yr from 2002 to 2004. Estimates of future exports of halon 1301 balance domestic demand and export earnings. (Annual halon 1301 export 1997-2002: reduced by 25 MT/yr. from 1997-99; by 50 MT/yr. 99-00; and by 100 MT/yr. 00-02 Annual halon 1301 export 2000 -2008 constant export of 100 MT/yr.)

1995 stock of halon 1211 and 1301 in fire extinguishers and systems : For halon 1211, based on annual production during the past decade and estimated retirement rates. For halon 1311, based on annual production in the last five years. (The halon 1301 figure excludes halon 1301 imported into China in systems which is estimated to be 1,000-1,500 MT. Because halon 1301 imports are excluded from the models stock calculations servicing demands are underestimated.)

Servicing rate: Assumed to be 3 percent of installed fire extinguishers per annum, based on a study carried out by MPS.

Chemical costs: Based on quotations from chemical suppliers

Capital costs of extinguisher facility conversion: These costs are based on the eligible cost categories in document UNEP/OzL.Pro/ExCom/20/66. Although these cost categories have not yet been endorsed by the Executive Committee, the implementing agencies have been asked to use them when preparing projects for the halon fire extinguisher subsector (Decision 20/46).

Cost of recycling machines and reclamation equipment: Based on recent price quotations provided by FRC and Getz. (recycling machines are also used to recover halon.)

Capital cost for storage of halon for banking: Assumed to be \$800 per metric ton of halon, and equivalent to the cost of a storage tank with capacity of 20-40 m3. Capital costs do not include labor costs for installation, civil works or land.

II. Specific Model Inputs, Calculation Methodology, and Output By Cost Component

1. Premature Closure Of Halon 1211 Producers

Output Eligible Economic Incremental Cost (EEIC) to be met by Multilateral Fund (MLF) stated as the net present value (NPV) in constant 1997 dollars = \$14.7 million

Additional Inputs

Profit rate for small halon 1211 producers:	9.00%
Profit rate for large halon 1211 producers:	11.94%
Compensation for labor:	\$488/ton halon
Remaining life for small halon 1211 producers:	8 yrs (production until end of 2004)
Remaining life for large halon 1211 producers:	13 yrs (production until end of 2009)

Profit rates for halon 1211 producers: Profit rates used are the average of individual profit rates for all similar enterprises based on financial information provided by enterprises. There are only two large producers (Shouguang fire Extinguishing Agent Plant and Dongyang Chemical Plant). Their profit rates are higher due to superior technical processes, distance from raw material suppliers, and economies of scale. The profit rates take into account the higher maintenance costs for large producers needed to keep the plants running another 10 to 20 years and social obligations for retired workers.

Compensation for labor per ton of halon produced: Compensation for labor is calculated on the basis of the average number of workers per ton of halon 1211 produced in the whole industry in 1995 and the average 1995 salary; these figures are taken from financial information provided by all halon 1211 producers. The calculation produces an estimate of the annual labor cost per ton of halon produced (\$256/MT), and since Chinese law requires two years of compensation to be paid, the figure for compensation estimated in the model is the NPV of two years' labor cost.

Remaining life of halon 1211 producers: Most plants were established between 1986-1989, but due to better equipment and greater investment in maintenance at the two large facilities, their plant life is expected to be about five years longer than that of the smaller facilities (average remaining life for large plants is 13 years, whereas it is eight years, on average, for smaller plants).

Calculation Methodology

Incremental costs for premature closure of halon 1211 producers are calculated as lost profit plus labor compensation (that is, value-added). Lost profits are calculated within the model as the NPV of the difference between, on the one hand, the stream of profits that would have been made assuming that production continued at 1995 levels until the end of plant life (as explained above) and, on the other hand, the stream of profits made on production under the phaseout scenario. Labor compensation costs were calculated as the tonnage of halon production to be reduced in each period times the NPV of two years of the annual cost of labor per ton of halon produced.

2. Conversion Of Halon 1211 Fire Extinguisher Producers

Output EBIC to be met by the MLF stated as NPV in constant 1997 dollars = \$19.4 million

Additional Inputs

20 small enterprises (up to 20,000 extg/yr.) 1995 halon 1211 consumption	404 MT
25 medium enterprises (20,000 to 75,000 extg/yr.) 1995 halon 1211 consumption	1,814 MT
27 large enterprises (more than 75,000 extg/yr.) 1995 halon 1211 consumption	5,091 MT
Annual incremental operating savings for halon to ABC	\$3.00/kg halon 1211
Annual incremental operating cost for halon to CO ₂	\$5.10/kg halon 1211
Annual incremental operating savings for halon to AFFF	\$2.30/kg halon 1211
Duration for incremental operating costs/savings	six months

Incremental operating costs for conversion from halon to ABC extinguishers: assumed to be a cost saving of \$1.5 per kg for a six-month period, on the basis that one kg of halon is equal to 1.5 kg of ABC powder. The calculation takes into account UNEP/OzL.Pro/20/66 and information on performance of various types of portable extinguishers in China.

Incremental operating costs for conversion from halon to CO₂ extinguishers: assumed to an incremental cost of \$2.55 per kg, on the basis that one kg of halon is equal to 3 kg of CO₂. The calculation takes into account UNEP/OzL.Pro/20/66 and information on performance of various types of portable extinguishers in China.

Incremental operating costs for conversion from halon to AFFF extinguishers: assumed to be a cost saving of \$1.15 per kg, on the basis of one kg of halon equal to 4 kg of AFFF. The calculation takes into account UNEP/OzL.Pro/20/66 and information on performance of various types of portable extinguishers in China.

Duration of Incremental Operating Costs: six months is used as per the decision on agenda item 10 at the 16th Meeting of the Executive Committee.

Calculation Methodology

Reduced halon availability. Halon is divided among various competing demands. As halon production is reduced, the model gives priority to exports, servicing and new system production. The remainder is the amount of halon 1211 available for halon extinguisher production. The reduced availability of halon 1211 for the fire extinguisher industry would cause enterprises to convert to alternatives or shut down production. However, as nine halon extinguisher manufacturers have already been closed down, MPS has concluded that the rest are needed to meet demand for fire extinguishers as halon is phased out. Thus, no further consolidation is assumed and the model calculates the costs of the expected conversions.

Future market structure: Based on MPS assessment, the model assumes that the 15% of the future portable extinguisher market will be covered by clean gaseous agents (compared to the

current halon 1211 share of 22%). To achieve 15% clean agent extinguishers in the market, the current production of halon 1211 extinguishers must be converted to produce 65% clean agent and 35% non-clean agent extinguishers. Following MPS estimates, the model assumes that CO2 will be the clean agent used in portable fire extinguishers. Of the 35% non-clean agent, the model again follows MPS estimates that 31% will be ABC powder and 4% will be AFFF. Thus, the conversion rate is 65% CO2, 31% ABC, and 4% AFFF.

Incremental capital costs: The eligible capital cost per enterprise (given above) is multiplied by the number of enterprises (e.g., for the small enterprise category, the calculation is $\$72,500 \times 20$). The total capital cost for the size category is then divided by the total annual halon consumption in 1995 for that category of enterprises to yield a unit incremental capital cost in terms of \$/kg of halon to be phased out by that group of enterprises.

Incremental operating costs/savings for small, medium and large enterprises: Given the calculated conversion rate, six months incremental operating costs for small and medium enterprises converting to ABC and CO2 extinguishers will be \$1.19 per kg of halon phased out and for large enterprises converting to ABC, CO2 and AFFF extinguishers \$1.14 per kg of halon phased out.

Annual conversion cost calculation: The model assumes that the small enterprises will convert first followed by the medium and then the large. Thus, the first 404 tons of halon 1211 to be phased out are costed on the basis of capital costs for small enterprises (in terms of \$/kg halon phased out) plus six months of incremental operating costs. Likewise, the incremental cost of phaseout of the next 1,814 tons is based on \$/kg costs for medium enterprises, and so on.

3. Conversion Of Halon 1211 Systems

Output. EEIC to be met by the MLF stated as NPV in constant 1997 dollars = \$7.1 million

Additional Inputs

Phaseout schedule:	50 tons reduction per year between 1997-2004 ¹
Substitute for halon 1211:	FM 200
Conversion ratio between halon 1211 and FM 200:	1:1.7

Conversion ratio between halon 1211 and FM 200: assumed to be 1.7 kg of FM 200 for each kg of halon 1301, based on current international design standards for FM 200 fire systems.

Calculation Methodology

The annual reduction of halon 1211 production is assumed to have some impact on the availability of halon for fixed system manufacturers. The reduced availability of halon 1211 for the fire extinguishing systems would cause enterprises manufacturing them to convert to

¹ A 100 ton reduction is assumed between 2000 and 2001 and 100 ton consumption in 2005 -- the last year.

alternatives or shut down production. The model calculates the incremental cost of these reductions based on one year of incremental operating cost; that is, the incremental cost of substituting FM 200 for halon in new systems for that year. Although actual use of halon 1211 in new systems may rise from 1995 levels, the model only calculates incremental cost of phaseout for the baseline halon 1211 consumption in 1995. No incremental costs are calculated for conversion of installed systems or for conversion of system manufacturers. (As the model ignores the capital costs of conversion, it makes no assumptions as to the number of halon system manufacturers that would shut down as halon is phased out.)

The model uses FM 200 as a proxy for substitute system costs. According to HTOC members, the incremental installed cost of halon substitute systems such as Inergen and CO2 is either more expensive or roughly equivalent to FM 200.

4 Conversion Of Halon 1301 Systems

Output EEIC to be met by the MLF stated as NPV in constant 1997 dollars = \$6.0 million

Additional Inputs

Substitute for halon 1301

FM 200

Conversion ratio between halon 1301 and FM 200

1:1.7

Conversion ratio between halon 1211 and FM 200: assumed to be 1.7 kg of FM 200 for each kg of halon 1301, based on current international design standards for FM 200 fire systems.

Calculation Methodology

Produced halon is divided among various competing demands. As halon 1301 production is reduced, the model gives priority to exports (which are also reducing) and servicing. The remainder is the amount available for new systems. The reduced availability of halon 1301 for the fire system industry would cause systems manufacturers to convert to alternatives or shut down production.

Essentially the same as for halon 1211 systems described above. No incremental costs are calculated for conversion of installed systems or for conversion of system manufacturers. (As the model ignores the capital costs of conversion, it makes no assumptions as to the number of halon system manufacturers that would shut down as halon is phased out.) As noted under halon 1211 system costs, the model uses FM 200 as a proxy for substitute system costs.

5. Modification of Halon 1211 Extinguisher Servicing Stations To Handle New Substitutes

Output EEIC to be met by the MLF stated as NPV in constant 1997 dollars = \$0.9 million

Additional Inputs

First year modification	2001
Rate of modification	Proportional to the decrease in halon stock

First year of modification: This is assumed to be the same year that stock of halon stored in extinguishers begins to decrease. The decrease in stock is a result of conversion of halon extinguisher manufacturers combined with retirement.

Calculation Methodology

As stock of halon goes down, a proportional number of servicing stations are assumed to convert. For example, if the stock decreases by 10% from 2005 to 2006 then 100 service stations would be modified in 2006 (the stock actually decreases about 3% per year). By the year 2010, about one-third of the service stations are modified.

6. Recovery, Recycling and Reclamation Of Halon 1211 From Extinguishers

Output BEIC to be met by the MLF stated as NPV in constant 1997 dollars = \$0.5 million

Additional Inputs

Major servicing centers lacking recycling equipment	850
Required number of reclamation centers	5
IOS from recycling halon 1211 from extinguishers during servicing:	\$1.70/kg
IOS from recovery and reclamation of halon 1211 from old retired ext.:	\$1.70/kg
IOC of recovery and reclamation of halon 1211 from prematurely retired ext.:	\$1.14/kg
Re-useable percentage recovered from old retired extinguishers:	20%
Recycled percentage from extinguishers during servicing:	10%
Re-useable percentage from halon in stock of extinguishers recovered from prematurely retired extinguishers:	0.15%
Retirement rate:	3 % increasing to 7%

Extinguisher retirement rate (replacement rate): Assumed to be 3% per annum through 1999; 4% through 2004; 5% through 2009; and 7 % through 2015 on the basis of estimates of the current and previous situation by MPS. The increasing retirement rate is due, in part, to the aging life of the stock and also due to premature retirement of halon extinguishers from non-essential uses beginning in 2003.

Re-useable percentage of halon 1211 from retired extinguishers: 20 percent of the halon originally charged in the retired extinguishers is assumed to be recoverable. In 2003, the Chinese government will begin to retire halon 1211 extinguishers installed in non-essential use applications so that their halon can be made available for essential uses. It is assumed that 0.15% of halon originally charged in the stock of halon extinguishers will be recovered and reclaimed for re-use from prematurely retired extinguishers.

Incremental operating savings/benefit from recycling re-useable halon 1211 during servicing of extinguishers: Net operating cost to recycle 1 kg of halon 1211 from extinguishers is about \$1.00 (including labor, energy and maintenance costs). Because halon 1211 sells for \$2.70 per kg in China, the servicing centers have a net incremental benefit of \$1.70 per kg of halon recycled. Because halon is refilled into the extinguisher from which it was removed, the halon need not be reclaimed.

Incremental operating savings/benefit from recovery and reclamation of re-useable halon 1211 from old retired extinguishers: Although the incremental operating costs associated with recovery and reclamation would be greater than for simple on-site recycling they are assumed to be the same (recycling does not clean halon to virgin condition and so it can not be used in an extinguisher other than the one from which it was taken without further processing. Thus, halon from retired extinguishers must be reclaimed at a centralized reclamation facility prior to re-use.).

Incremental operating cost of re-useable halon 1211 recycled from prematurely retired extinguishers: This incremental operating cost is based on the same assumptions for labor, energy and maintenance used for on-site recycling (even those these underestimate the costs of recovery and reclamation), and also includes the costs of replacing the prematurely retired extinguisher with a new ABC powder extinguisher. The incremental operating cost of recovering and reclaiming halon 1211 from prematurely retired extinguishers is thus \$3.84 per kg. Because halon 1211 sells for \$2.70 per kg in China, the reclamation centers would have a net incremental cost of \$1.14/ kg recycled halon. Premature retirement begins in 2003 coinciding with ceasing of production of new halon 1211 extinguishers.

Installation of recycling machines and reclamation equipment: China has already installed about 150 halon 1211 recycling units with MLF support. For the model, only recycling from additional recycling machines and reclamation equipment are considered. These are assumed to be installed in 2002 so that recycling, recovery and reclamation can begin in 2003. This additional halon is needed for servicing to offset reductions in halon 1211 production.

Number of reclaiming centers/machines for halon 1211: MPS has decided to make the halon 1211 reclamation sites the same as those for halon 1301. As stated below, MPS decided to locate these reclamation centers in geographically strategic locations to cover major halon 1301 use areas around China. Preliminary decision is to locate centers in Beijing, Shanghai, Tianjin, Guangdong and Sichuan Province. (On average, one center would service a stock of halon 1211 in extinguishers greater than 8,000 MT)

Number of major halon 1211 extinguisher service centers: There are 1000 halon 1211 licensed service centers in China according to MPS. Of these, 150 have already received halon 1211 recycling machines with MLF support. Thus, only the remaining 850 require halon 1211 recycling equipment.

Calculation Methodology

The capital costs for the recycling machines and reclamation equipment are assumed to be required in 2002. Beginning in 2003, the net operating costs and savings are calculated for each year until 2010 based on the amount of halon recycled or reclaimed.

7. Recovery and Reclamation Of Halon 1301

Output: EEIC to be met by the MLF stated as NPV in constant 1997 dollars = \$0.2 million

Inputs

Re-useable percentage of halon recovered from retired of 1301 systems	50%
Required number of halon 1301 recovery centers (one machine per center)	20
Required number of halon 1301 reclamation centers	5
IOS for recovery of 1301	\$ 3.00/kg

Re-useable percentage of halon 1301 from retired of systems: assumed to be 50%, on the basis of estimates made by MPS and experience of developed countries.

Number of recovery machines for halon 1301: assumed to be 20, located in the main cities and industrial centers throughout China.

Number of reclaiming centers/machines for halon 1301: Based MPS decision to locate reclamation centers geographically strategic locations to cover major halon use areas around China. Preliminary decision is to locate centers in Beijing, Shanghai, Tianjin, Guangdong and Sichuan Province. (On average, one center would service a stock of halon 1301 greater than 600 MT)

IOS for recycling halon 1301: Net operating cost to recycle 1 kg of halon 1301 from extinguishers is about \$3.00 (including labor, energy and maintenance costs). Because halon 1211 sells for \$8.50 per kg in China, the servicing centers have a net incremental benefit of \$5.50 per kg of halon recycled. As halon 1301 is taken from retired units, reclamation is required prior to re-use. The additional incremental operating costs of reclamation are, however, not considered.

8. Banking Of Halon 1211 (From Extinguishers) and Halon 1301

Outputs EEIC to be met by the MLF stated as

NPV in constant 1997 dollars for halon 1211 = \$3.7 million

NPV in constant 1997 dollars for halon 1301 = \$0.2 million

Additional Inputs

Incremental operating costs for halon banking: \$0.50/kg/yr.

Operating Costs for halon banking: assumed to be \$0.50 per kg, based on maintenance and day-to-day handling costs, including labor.

Calculation Methodology

The capital cost of establishing the bank is considered for the year in which the halon is banked. For example, if 100 tons of halon 1211 are banked in 2007, then both the capital cost (\$800/MT) and the operating cost would be included in costs for 2007. In subsequent years, additional capital costs are only considered for new halon added to the bank. Operating costs, on the other hand are considered for all halon in the bank.

9. Destruction of Halon 1211 (From Retired Extinguishers)

Output: EEIC to be met by the MLF stated as NPV in constant 1997 dollars = \$0.4 million

Additional Inputs

Contaminated percentage of reclaimed halon	5.0%
Incremental operating cost for halon destruction	\$ 6.00/kg

Cost of destroying contaminated halon: Assumed to be \$6 per kg. Cost includes labor and energy.

Percentage of recovered halon that is contaminated and destroyed: Assumed to be 5% of recovered halon, on the basis of estimates made by MPS.

Calculation Methodology

Halon recovery from retired extinguishers begins in 2003 after halon 1211 production has been reduced by 80 percent from 1995 baseline. The amount of recovered halon 1211 is calculated by the model based on assumptions about extinguisher retirement and the stock of halon 1211 stored in extinguishers. Five percent of this recoverable amount is assumed to be contaminated and require destruction each year. Only the incremental operating cost is considered in calculating the eligible incremental costs for halon 1211 destruction.

10. Plant for 1301 Substitute

Note: This cost was included instead of the closure costs for the 1301 plant. However, as the EC is close to approval of production sector closure guidelines, but has yet to consider eligible incremental costs for production sector conversion projects, the Bank is working with China to recalculate the halon 1301 production phaseout cost as a closure cost.

Output: EEIC to be met by the MLF stated as NPV in constant 1997 dollars = \$0.6 million
(technology transfer fee would be in addition to this amount)

Capital cost for 1301 substitute plant	\$1.2 million
Investment year	2005

Capital cost for 1301 substitute plant. Based on estimates by MPS of equipment costs. MPS has no information on technology transfer costs and so those costs have yet to be included.

Calculation Methodology

The cost is simply the NPV of the capital cost required in the year 2005.

IV. ACTION PLAN

1. This chapter presents the plan for implementing the halon phaseout schedule proposed in chapter 3, including annual phaseout targets, MLF funds required to meet those targets (based on cost analysis presented in chapter three), and key policy and other actions that will be implemented to achieve the phaseout objectives. As long as funds are made available in a timely manner, the Government of China commits to realizing the halon phaseout by carrying out the following action plan which is divided into three stages:

- Stage one will begin following the Executive Committee's approval of funds and will continue through 1999. During this time, annual halon 1211 production will be reduced from 9950 MT to 4975 MT; a phaseout of almost 15,000 MT ODP.
- Stage two will be from 2000-2005, during which time annual halon 1211 production will be further reduced to 1985 MT and annual halon 1301 production will be reduced from 750 MT to 600 MT for an additional phaseout of over 10,000 MT ODP.
- Stage three will be from 2006-2010, during which the remaining 1985 MT of halon 1211 and 600 MT of halon 1301 are eliminated for an additional phaseout of almost 12,000 MT ODP.

4.1 Stage One: 1997-1999

2. Stage one will begin upon approval of the sector plan in 1997 and continue through December 31, 1999. The phaseout time table, funding request and main phaseout actions for this stage are listed in Table 4-1. To achieve its target of 50 percent reduction in halon 1211 production from 1995 levels the Government of China will introduce a production quota system and grant bidding scheme that will lead to the closure of a certain number of halon 1211 agent manufactures (or production lines) and the conversion of several halon 1211 extinguisher enterprises. To meet essential uses, China will maintain its halon 1301 production at 1995 levels during this stage.

Table 4-1 Halon Phaseout Plan Stage One: Phaseout, Funding Requests, and Actions

Phaseout and Funds	Baseline (1995)	1997-1998 ¹¹	1999
Production target halon 1211 halon 1301	9,950 MT 750 MT	7,010 MT 750 MT	5,020 MT 750 MT
Production phaseout target ¹² halon 1211 halon 1301		2,940 MT 0	1,990 MT 0
Consumption phaseout target ¹³ halon 1211 halon 1301		2,385 MT 0	1,790 MT 0
Required funding from MLF (NPV in 1997 constant \$)		\$18,884,000	\$ 8,588,000
Funding request from MLF (PV of each year, in '97 \$) ¹⁴ of which TA		\$20,015,000 \$ 2,310,000	\$10,392,000 \$ 1,050,000
Policy and Other Actions	1997-1998		1999
Phaseout Measures	• close about nine H1211 production enterprises; • convert H1211 extinguisher producers; • begin construction of an ABC powder plant.		• close H1211 production lines/enterprises; • convert H1211 extinguisher producers; • continue construction of ABC powder plant.
Policy Measures	• adopt regulations on halon extinguisher servicing enterprises; • revise fire protection building design codes; • adopt bidding system to support production closure and conversion of halon extinguisher and system enterprises; • implement quota system for halon producers	• revise technical standards for ABC dry powder • adopt policies for encouraging production of halon agent substitutes; • revise fire protection underground engineering design code • adopt regulation on import and export of halon agents;	• adjust the definition of "non essential use (area)".

¹¹ The "1997" refers to the duration from date of sector plan approval to December 31, 1997;

¹² The "phaseout amount" is the actual 1995 baseline production at the enterprises which will be closed.

¹³ The "phaseout amount" is the actual 1995 baseline consumption at the enterprises which will be converted.

¹⁴ The "funding request from MLF" is derived from the cost analysis described in chapter 3. These figures have not been indexed for inflation. Actual requests would be higher depending on agreed inflation index.

Policy and Other Actions	1997-1998 ¹⁵	1999
Technical Assistance Activities	• conduct campaign (publicity, training, etc.) for promoting ABC powder as halon substitute; • investigate and develop halon import and export management policies; • develop halon sector plan sector management information system (MIS); • prepare the standard for FM 200 extinguishing agent and FM 200 extinguishing systems; • prepare standards for inert gas fire extinguishing systems; • prepare codes for designing inert gas fire extinguishing systems; • establish testing laboratory for inert gas fire extinguishing systems; • revise technical standards for ABC dry powder; • conduct other education and training programs; • institutional strengthening	• introduce techniques for using halon substitutes; • train and educate fire protection officials.

4.2 Stage Two: 2000-2005

3. Stage two begins on January 1, 2000 and ends on December 31, 2005. The phaseout timetable, funding request and main phaseout actions for this stage are listed in Table 4-2. During this stage, the Government of China will continue to close a certain number of halon 1211 agent manufactures (or production lines) through the bidding and quota systems. The Government will also continue to convert halon 1211 extinguisher producers by offering assistance through the grant bidding mechanism. Beginning in 2003, the Government will establish a bank for halon 1211, begin modification of halon 1211 extinguisher servicing centers to service extinguishers produced with halon substitutes, and enforce reclamation standards for recovered halon 1211. To continue to meet essential use requirements, the Government will only require a small reduction in the production of halon 1301.

At the end of Stage Two China will have:

- Completely stopped halon 1211 production;
- Shut down all halon 1211 producers;
- Converted all halon 1211 extinguisher and system manufacturers;
- Begun using recycling equipment at all licensed halon 1211 extinguisher service stations; and
- Banked about 3000 MT of reclaimed halon 1211 (to meet servicing needs until 2010).

¹⁵ The "1997" refers to the duration from date of sector plan approval to December 31, 1997;

Table 4-2 Halon Phaseout Plan Stage Two: Phaseout, Funding Requests, and Actions

Phaseout and Funds	2000	2001	2002	2003	2004	2005
Production target						
halon 1211	3,357 MT	2,694 MT	2,030 MT	2,030 MT	2,030 MT	2,030 MT
halon 1301	750 MT	600 MT	600 MT	600 MT	600 MT	600 MT
Production phaseout target ¹⁶						
halon 1211	1,663 MT	663 MT	664 MT	0	0	0
halon 1301		150 MT				
Consumption phaseout target ¹⁷						
halon 1211	1,458 MT	463 MT	563 MT	0	0	0
halon 1301		150 MT				
Funding request from MLF (NPV in 1997 constant \$)	\$7,824,000	\$3,951,000	\$ 6,233,000	\$1,934,000	\$1,687,000	\$2,058,000
Funding request from MLF (PV of each yr in 1997 \$) ¹⁸						
of which TA	\$10,414,000 \$ 980,000	\$5,785,000 \$ 840,000	\$10,039,000 \$ 700,000	\$3,426,000 \$ 560,000	\$3,288,000 \$ 560,000	\$4,411,000 \$ 420,000
Policy and Other Actions	2000-2002			2003-2005		
Phaseout Measures	• Close H1211 production lines/enterprises; • Convert H1211 extinguisher producers.			• Establish H1211 bank; • Modify H1211 extinguisher service stations; • Reclaim H1211 from retired extinguishers; • Close remaining H1211 agent producers by the end of 2005; • Convert remaining H1211 extinguisher manufacturers; • Convert H121 system manufacturers.		
Policy Measures	• Adjust the definition of "nonessential use (area)"			• Adjust the definition of "non essential uses (area)"		
Technical Assistance Activities	• Publicize halon phaseout plan and educate officials, managers and public; • Train fire officials and engineers • Evaluate effect of policies to date			• Publicize halon phaseout plan and educate officials, managers and public; • Train fire officials and engineers • Evaluate effect of policies to date		

¹⁶ The "phaseout amount" is the actual 1995 baseline production at the enterprises which will be closed.

¹⁷ The "phaseout amount" is the actual 1995 baseline consumption at the enterprises which will be converted.

¹⁸ The "funding request from MLF" is derived from the cost analysis described in chapter 3. These figures have not been indexed for inflation. Actual requests would be higher depending on agreed inflation index.

4.3 Stage Three: 2006-2010

4. Stage three begins on January 1, 2006 and ends December 31, 2010. The phaseout time table, funding request and main phaseout actions for this stage are listed in Table 4-3. During this stage, the Government of China will continue recycling and reclaiming halon 1211 and will draw from the halon 1211 bank to minimize pre-mature retirement of halon 1211 fire extinguishers and systems. In 2007, the Government will establish a bank for halon 1301 and enforce reclamation standards.

At the end of the Stage Three China will have:

- Completely stopped import and production of halon 1301;
- Shut down the halon 1301 producer;
- Converted all halon 1301 systems manufacturers; and
- Banked about 500 MT of reclaimed halon 1301.

Table 4-3 Halon Phaseout Plan Stage Three: Phaseout, Funding Requests, and Actions

Phaseout and Funds	2006	2007	2008	2009	2010
Production target					
halon 1211	0	0	0	0	0
halon 1301	150 MT	150 MT	150 MT	150 MT	0
Production phaseout target¹⁹					
halon 1211	2,030 MT	0	0	0	0
halon 1301	450 MT	0	0	0	150 MT
Consumption phaseout target²⁰					
halon 1211	1,000 MT	0	0	0	0
halon 1301	350 MT	0	0	0	0
Funding request from MLF (NPV in 1997 constant \$)	\$ 8,220,000	\$ 279,000	\$ 113,000	\$ 67,000	0
Funding request from MLF (PV of each yr in 1997 \$)²¹	\$19,383,000	\$ 723,000	\$ 325,000	\$ 210,000	0
of which TA	\$ 420,000	\$ 280,000	\$ 140,000	\$ 140,000	0

¹⁹ The "phaseout amount" is the actual 1995 baseline production at the enterprises which will be closed.

²⁰ The "phaseout amount" is the actual 1995 baseline consumption at the enterprises which will be converted. Conversion takes up to two years.

²¹ The "funding request from MLF" is derived from the cost analysis described in chapter 3. These figures have not been indexed for inflation. Actual requests would be higher depending on agreed inflation index.

Policy and Other Actions	2006-2009	2010
Phaseout Measures	- Establish H1301 bank; - Close H1301 agent producer in 2009; - Banked H1211 available in 2006; - Continue H1211 recycling and reclamation	Banked H1301 available;
Policy Measures	Adjust the content of "unessential uses".	- Enforce bans on halon production - Enforce bans on halon Ext/systems production
Technical Assistance Activities	- Publicize halon phaseout plan and educate officials, managers and public; - Train fire officials and engineers - Evaluate effect of policies to date	

4.4 Summary

5. Figures 4-1, 4-2, and 4-3, summarize the phaseout time schedule that will be followed through this action plan:

Fig. 4-1 Halon 1211 Phaseout of China Fire Protection Sector

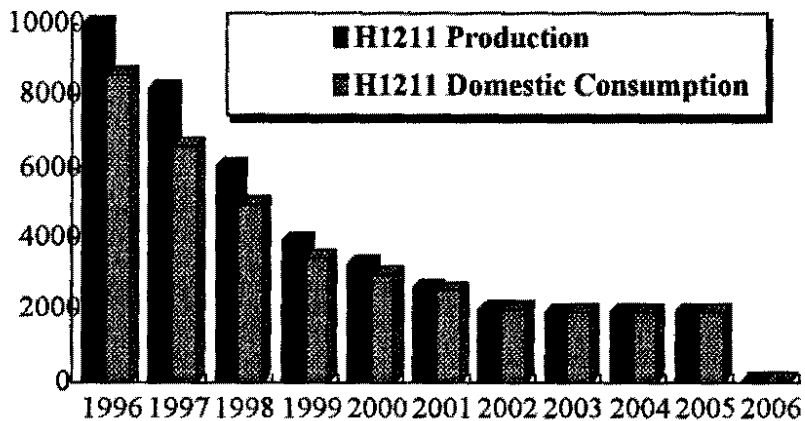


Fig. 4-2 Halon 1301 Phaseout of China Fire Protection Sector

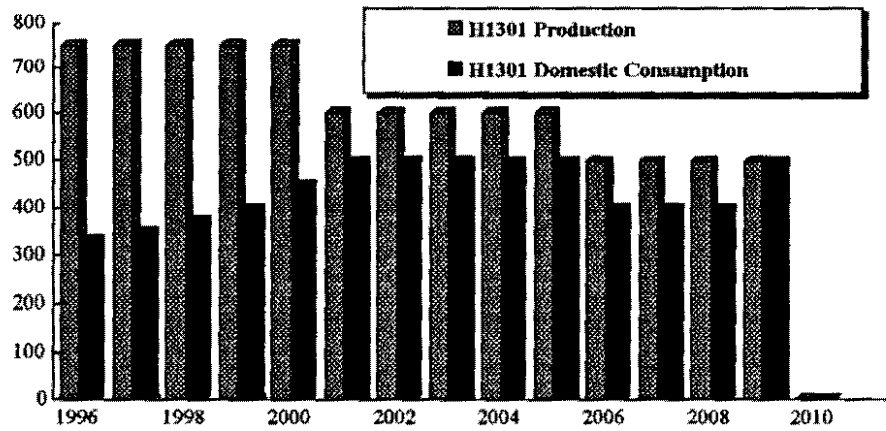
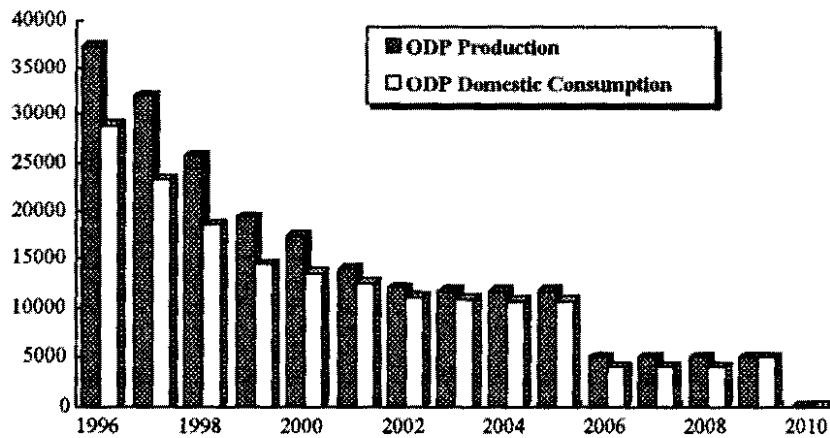


Fig. 4-3 ODP Phaseout of China Fire Protection Sector



V. OPERATING MECHANISMS OF THE SECTOR PLAN FOR HALON PHASEOUT

1. Upon approval of this sector plan, the Government of China will introduce additional policy measures and take other actions, as described in chapter two, to achieve a rapid cost-effective halon phaseout. This chapter explains the funding arrangements, operating mechanisms, and the responsibilities of the institutions involved in implementation of this sector plan.

A. Funding Arrangements

MLF Approval

2. Funds for this halon sector phaseout plan would be approved in two steps:

- First, the Chinese Government, through the World Bank, requests the Executive Committee to consider this overall sector phaseout plan and agree to fund halon phaseout with annual advances as described in chapters three and four provided that China meets the annual phaseout targets in chapter four. At the same time, China requests the EC to fund the first implementation plan for 1997-98 as described in chapter four.
- Secondly, the Chinese Government, through the World Bank, will request funds at the end of each year to implement annual phaseout plans for the subsequent years beginning with the 1999 annual plan funding request. For example, The World Bank, on behalf of the Government of China, would submit the 1999 annual plan to the EC in time to allow for funding approval by November 15, 1998. The EC would be asked to approve funding at the levels agreed to in this sector plan based on achievement of previous phaseout targets.

3. In general, approval of the funds would be based on achievement of halon phaseout targets (production targets for the previous year not exceeded):

- The 1999 annual plan funding request would be based on the first two semi-annual progress reports. (The 1997-98 production target would be achieved by the end of 1998 as the quota system would be put in place in 1997 following approval of this sector plan.)
- Annual plan funding requests for the years 2000-2009 would be based on achievement of halon phaseout targets for the previous year and the semi-annual progress report for the current year. For example, 2000 funds would be approved based on 1997-98 phaseout and the 1999 mid-year progress report, 2001 funds on 1999 phaseout and 2000 progress, and so on.

If phaseout targets for previous year were not obtained, the Bank and China would agree on remedial actions. New funding requests to the EC would go forward only after phaseout targets had been met.

4. *Annual plans* (beginning with the 1999 annual plan) would comprise three sections:

- performance on national level halon production reductions and other annual plan targets in previous year
- status of activities in current year including halon plant closures completed, and
- objectives, targets and planned activities for coming year

5. The third section would also include a description of technical assistance activities needed to support the program implementation, a planned disbursement schedule, and schedule for all planned activities. The World Bank would approve technical assistance activities consistent with the annual plan based on agreed terms of reference up to level of TA funding approved under the annual plan for that year.

Allocation and Disbursement of Funds within China

6. *World Bank disbursement to China* -- Upon approval of the halon sector approach and funding for the year, the Bank will advance a lump sum of grant funds to the Government of China to be deposited in a bank account set up by China's Ministry of Finance (MOF). The Government, with assistance of an appointed agent (the "Domestic Implementing Agency" - DIA), will disburse funds from the bank account to selected beneficiaries for both technical assistance and enterprise level halon phaseout activities. As the bank account is depleted, the Government would submit replenishment requests to the World Bank. Each replenishment request would include a progress report indicating performance on agreed indicators (sample performance indicators are given in Table 5-1). The World Bank would replenish the bank account provided progress on implementation of the annual plan is satisfactory. If performance is unsatisfactory, the World Bank and China would agree on remedial action.

7. *Chinese Government allocation of funds to halon enterprises for phaseout projects* -- As noted in chapter two, funds will be allocated to halon producers and extinguisher and system manufacturers through a bidding system. The bidding system as a means of grant allocation is new to both China and the MLF²², thus it is expected that the system will evolve over time as experience is gained. The initial plan is to offer one bid prior to the year in which closure and conversion projects would be implemented (*i.e.*, enterprises closing or converting in 1998 would bid for grants at the end of 1997). The bid would be run at the end of the year in parallel to EC consideration of the next year's annual plan. Enterprises successful in their bids for MLF grants would be selected following EC approval of funds for the next year's annual plan. Winning enterprises would sign "ODS reduction contracts" with the Government. The Government would entrust the DIA to supervise contract implementation. Local government agencies would also be involved in monitoring implementation as necessary.

²² A bidding scheme for grant allocation is being piloted in Chile with MLF support through the World Bank, but results are not yet available. Moreover, the differences between the two economies are so substantial, lessons learned from the Chile experience may or may not have application in China.

8. Disbursement of grant funds would be based on implementation progress. For example, disbursement for closure projects (bid winners) would follow a schedule something like:

- 10% initial payment upon signing of ODS reduction contracts;
- 70% payment following dismantling of production equipment; and
- 20% payment on DIA's confirmation of enterprises' project completion report.

9. For all enterprise-level halon phaseout activities disbursements will be linked to phaseout progress. If closure and conversion projects lag behind schedule, the DIA would notify the appropriate government authorities who would take action to get projects moving. Disbursements would proceed only after progress toward halon phaseout is evidenced.

B. Halon Sector Plan Management And Coordination

10. This Halon Sector Phaseout Plan will be executed by the Government of China. As described below, two Chinese government agencies, the National Environmental Protection Agency and the Fire Protection Bureau of the Ministry of Public Security manage and coordinate execution of each year's annual plan. In addition, NEPA will contract a consulting firm to help manage day to day activities. As the selected MLF Implementing Agency, the World Bank will supervise overall implementation of this sector phaseout plan, replenish the local project bank account, report to the Multilateral Fund Executive Committee on implementation progress, and submit future funding requests to the EC. During the first stage of the halon sector plan, the Bank will conduct yearly technical audits to confirm annual halon production levels.

The national execution management and coordination functions are as follows:

11. **Government Project Management Office (PMO)** is an administrative office within the National Environmental Protection Agency (NEPA) with overall responsibility for implementation of China's ODS Phaseout Country Program and for ensuring that the halon sector phaseout is consistent with the Country Program. Under the halon sector plan the PMO will:

- contract out day-to-day supervision of enterprise level activities in the halon sector to a Domestic Implementation Agent (DIA)²³;
- set up and implement a monitoring and reporting system including an MIS to track implementation of annual plans;
- report to the World Bank on annual plan implementation;
- review bid winner selection;
- authorize disbursements to enterprises following DIA review;
- monitor and enforce the halon production quota system;
- implement technical assistance activities with MPS and other relevant ministries, and

²³ The DIA will be selected by NEPA from a shortlist of consultant firms agreed with the World Bank that are experienced in financial and project management. The selection process is underway.

- oversee preparation of audit reports.

12. On a day-to-day basis, the local environmental protection bureaus will, on behalf of the PMO, conduct random visits to beneficiary enterprises to confirm halon phaseout.

The Domestic Implementation Agent (DIA) -- Under the guidance of the PMO, it will:

- run the annual bidding process to allocate halon phaseout grants;
- supervise implementation of enterprise closure/conversion projects selected through the bidding process;
- review disbursement requests from enterprises and submit to PMO for payment;
- report to PMO on status of enterprise project implementation; and
- identify and alert PMO about any issues arising during closure/conversion project implementation.

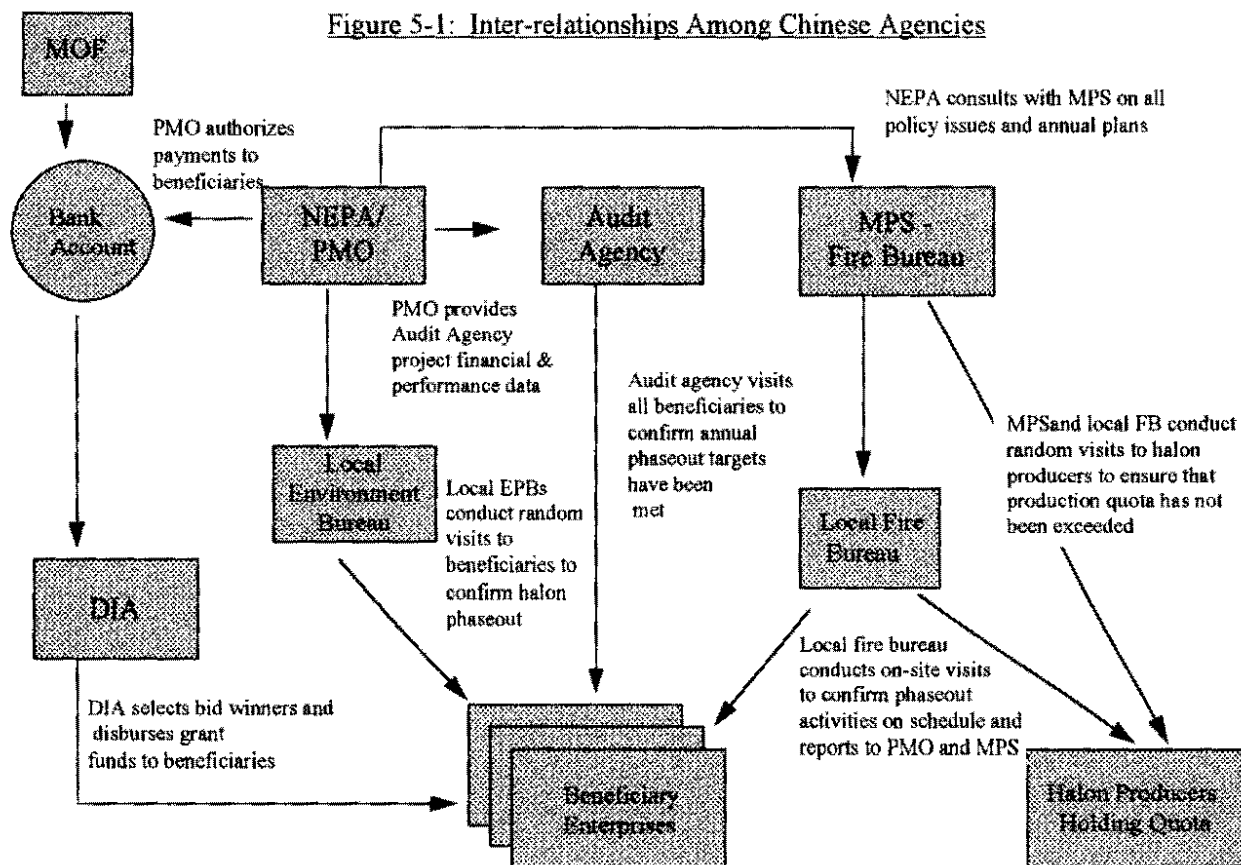
13. **The Fire Protection Bureau of the Ministry of Public Security (MPS)** -- Working closely with the PMO, MPS will play an important role in preparation and implementation of each year's halon sector phaseout annual plan. Specifically, MPS and its research institutes will be active in:

- halon substitute chemical development;
- development, implementation, and enforcement of halon phaseout policies including the non-essential use ban;
- monitoring halon producer compliance with quota system; and
- ensuring that adequate fire fighting capabilities are maintained throughout the country.

14. On a day-to-day basis, the local fire bureaus will monitor compliance with policies and on behalf of the PMO will conduct random visits to beneficiary enterprises to confirm project progress.

15. The inter-relationships among Chinese agencies involved in halon sector plan implementation are diagrammed in Figure 5-1.

Figure 5-1: Inter-relationships Among Chinese Agencies



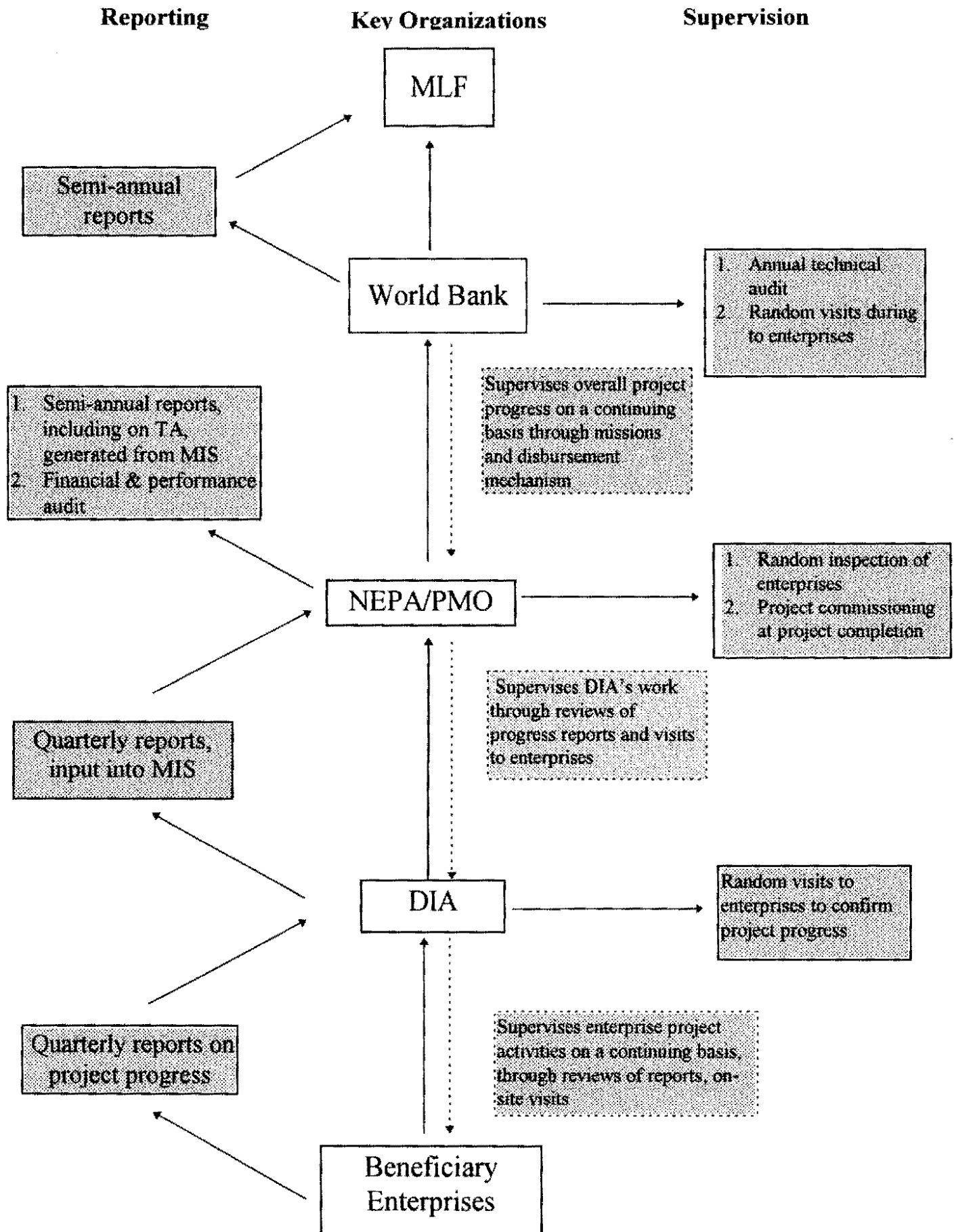
Monitoring and Evaluation

16. The PMO is the focal point for monitoring implementation of annual halon sector phaseout plans and reporting to the World Bank. Figure 5-2 (on the page 47) diagrams information flows related to project monitoring, reporting, supervision, and evaluation. Progress on halon reduction projects (which have been selected through the bidding scheme) will be tracked by the DIA who will submit written progress reports to the PMO four times a year. Implementation of policy measures and technical assistance activities will also be tracked by the PMO. The PMO will report to the Bank twice a year on all activities agreed in the annual plan. The World Bank will report twice annually to the Executive Committee, one mid-year report and one report following completion of each year's annual plan.

17. Performance indicators for each type of activity have been discussed and final indicators will be agreed prior to disbursement of funds. Table 5-1 gives examples of the type of indicators which will be used to assess halon phaseout performance. Once the Bank and NEPA have agreed on performance indicators and NEPA has indicated who will provide information, when information will be provided and its relevance, a computer-based management information system (MIS) will be designed as a management tool to facilitate program monitoring, evaluation and reporting.

Table 5-1 Sample Halon Sector Annual Plan Performance Indicators

Halon Phaseout Targets	Draft Performance Indicators
⇒ Production target ⇒ Production phaseout target ⇒ Consumption phaseout target	• Annual production of each halon producer • Number of halon producers closed and amount of halon reduced • Halon exports and imports • Import amount for the year • Consumption (domestic production + import - export) of halon for the year • Number of extinguisher/system enterprises converted and halon reduced
Phaseout Measures	
⇒ Producer closures and extinguisher/system manufacturer conversions	• Number of enterprises awarded grant for closure through bid • Number of enterprises awarded grant for conversion through bid • Date ODS reduction contracts signed • Date closures/conversions complete and halon phased out • Date conversions complete and halon phased out
⇒ Substitute agent plant construction	• Date substitute agent plant complete and expected production
Policy Measures	
⇒ Implement quota system for halon producers	• Date quota issued to enterprises • Date enterprises submit reports on halon production • Completeness of halon production reports • Annual production and quota for each enterprise
⇒ Adopt bidding system to support closure and conversion projects	• Date and number of bids received • Price of enterprise bids and phase out amount • Total amount of quota bought through bid • Number of conversions awarded grants • Date ODS reduction contracts signed • Date of first disbursement • Date of halon phaseout • Date completion report verified
Technical Assistance	
⇒ MIS development	• Computer network installed and tested • Database design complete and data entered

Figure 5-2 Information Flows

REVIEW OF PLAN FOR HALON PHASEOUT IN CHINA

Scope

The project under review covers the phaseout of halons 1211 and 1301 used in the fire extinguisher manufacturing and fixed fire system installations in China and the proposed non-ODS replacement agents for these extinguishers and systems.

Technology

- a) The technology of the production and manufacturing of fire extinguishers and fixed fire extinguishing systems is well established in China and does not present a technology challenge to the country.
- b) The primary extinguishing agent to be used for new portable fire extinguishers under this program will be ABC dry powder, rather than the BC powder currently used. It is important that the quality of the ABC dry powder be manufactured to a standard at least equivalent to US Federal specification number Q-D-1380A, Dry Chemical, Free Extinguishing, Multi-purpose Phosphate.
- c) Any alternate chemicals chosen as replacement for halon 1301 in fixed systems must conform to the quality standards established in the original formulations.

Environmental Impact

- d) The replacement agents proposed under the program for fire extinguishers have zero ODP values and, depending on the replacement agent chosen, have GWP and atmospheric lifetime characteristics that are acceptable to China.

Project Costs

- e) The cost of "clean agent" gas/chemicals used in various phaseout analyses throughout the report are based on China either importing the agents, or substituting into direct licensing agreements with patent holders for production and/or manufacturing of these products.
- f) The cost models assume (pg26, 5621) that "Recycling machines will save 20 % of halon<1211> otherwise used for servicing. After discussion, the text will be altered to read "Recycling machines will save 20 % of the 3 % halon 1211 that is allocated to the servicing sector of the fire extinguisher industry."
- g) pg27, 5621, states that "It is estimated that 20 % of the amount of halon <1211> from retired extinguishers can be recovered". How was this figure arrived at, and, what happens to the remaining 80 %? After discussion, it was suggested that the word "retrieved" be changed to "recoverable".

97/03/25

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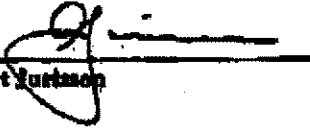
Recommendations

- b) Approval as proposed, after issues above have been addressed.

Comments

- i) The cost derivations, inputs and assumptions used in the assessment models have been reviewed and are realistic within the time frames stated.
- j) The concerns as expressed in para. 17 of the Fax message from Mr. El-Arini of the MLF Mr. Ken Newcombe of 6 January 1997 are noted. However, the statements are very subjective, as the extinguishing efficiency of the various agents is greatly influenced by many varying factors.

OORC Technical Reviewer


Art Justison

Date 97-03-25