United Nations Environment Programme

Distr.
GENERAL

UNEP/OzL.Pro/ExCom/8/25
21 September 1992

ORIGINAL: ENGLISH

Executive Committee of
the Interim Multilateral Fund for the
Implementation of the Montreal Protocol

Eighth Meeting
Montreal, 19-21 October 1992

MEETING OF THE NEEDS OF ARTICLE 5 PARTIES FOR CONTROLLED SUBSTANCES DURING THE GRACE AND PHASE-OUT PERIODS

(DRAFT REPORT)

EXECUTIVE SUMMARY

INTRODUCTION

1. The Open-Ended Working Group of the Parties to the Montreal Protocol requested, at its seventh meeting, the Executive Committee "to estimate the quantities of controlled substances required by countries operating under Article 5, paragraph 1, during their grace and phase-out periods, the extent to which the need could be met by existing production facilities and by recycling in countries operating under Article 5, paragraph 1, and the methods of meeting such needs in full. It also decided to recommend to the Fourth Meeting that such a process of estimation should be carried out on an ongoing basis".

2. The methodology used in calculating the estimated demand for controlled substances in Article 5 countries is based on calculation of expected growth and phase-out. Projection of production capacity and recycling of controlled substances in Article 5 countries was made to determine the extent to which these demands could be met.

3. The result of applying this methodology lead to the following conclusions:

(a) The estimated cumulative demand for controlled substances in Article 5 countries from 1992 to 2010 is about 1,810,000 tonnes.

(b) The forecast demand for CFC-11, CFC-12, CFC-114, Halon-1211 and Halon-1301 can be met by increased output from the existing production facilities of Article 5 producer countries up to 2010. However in 2007, the forecast demand for CFC-12 can only be partially met by existing production facilities in Article 5 countries but, might be fully met, if production is supplemented by expected recycled volumes. After 2010, recycled volumes could contribute significantly to meet forecast demand when production has ceased.

(c) The forecast demand for CFC-115, CFC-113 and methyl chloroform cannot be met by existing production facilities in Article 5 countries. The quantities the developed countries' producers are allowed to produce for export to Article 5 countries could be sufficient to meet the forecast demand. However, developed country capacity may be eliminated before these substances are phased-out in developing countries.

METHODOLOGY

4. Future demand for controlled substances in Article 5 countries was calculated by multiplying the base year consumption by growth and elimination factors. Production capacity and/or recycling of these substances in Article 5 countries were analyzed to determine the extent

to which these demands could be met. The assumptions used in this methodology are based on information included in country studies, country programmes, UNEP Technical Option Reports, and from suppliers in developed countries, implementing agencies' reports and others.

Growth

5. It is assumed that growth in demand for different countries in the absence of constraints will be between 7 percent and 10 percent per annum. These figures are broadly consistent with growth rates in country programmes.

Phase-out

6. For those countries that have country studies and/or country programmes completed, the elimination multipliers are based on the phase-out assumptions provided in these reports. For all other countries the following assumptions apply:

i) with the exception of essential uses, the use of CFCs in aerosols will be eliminated by 1997;

ii) 50 percent of the unconstrained demand for CFCs in foams will be eliminated by 1997. CFC use in rigid foams will be eliminated by 2005;

iii) 20 percent of the unconstrained demand for refrigerants will be eliminated by 1997. Refrigerant use in industrial applications will be eliminated in 2000, and in commercial applications, by 2005. About 10 million air-conditioned cars and trucks will be in service in Article 5 countries in 2010. Approximately one-third of the cars will require air-conditioning service each year. Forty-five percent of CFC-12-using, domestic refrigerators existing in 1995 will need recharge in 2010;

iv) the use of CFC-113 will be eliminated by 1999;

v) the use of methyl chloroform will be eliminated by 2005;

vi) the use of CFC-114 and CFC-115 will be eliminated by 2000; and,

vii) the use of halons will be eliminated by 2005.

Demand

7. In assessing demand for controlled substances in Article 5 countries the following procedures were followed:

(a) A base-line year was established for each country for which consumption of the various controlled substances is known. This base-line year was 1989, 1990, or 1991

depending on the information available.

(b) Demand was projected to 2010 using a growth multiplier for each country, to give an estimate of what the demand for controlled substances would be if there were no constraints on use or on supply.

(c) This unconstrained demand for each substance was reduced by an elimination multiplier for each year. The elimination multiplier for a particular year represents the projected percentage of most likely reduction in consumption by the end of that year.

8. The result of applying these growth and elimination multipliers to current consumption for each substance is the projected demand in each year to 2010. This method was used to calculate the projected demand for each substance for each Article 5 country, using growth and elimination multipliers that take into account the differing circumstances of individual countries. The results were then added to determine the forecast demand of Article 5 countries for each substance.

Supply from Article 5 Producer Countries

9. The future production capacity in Article 5 countries for individual controlled substances was estimated by adjusting downwards their existing production capacities by the stated intentions of transnational companies to eliminate capacity and by the production constraints of the Montreal Protocol.

RESULTS

10. The estimated demand for controlled substances in Article 5 countries has been derived by applying the methodology described in paragraphs 5 - 9 above. The methods of meeting these demands have been considered taking into account the provisions of the Montreal Protocol and information provided in the Country Programmes, included in UNEP Assessment Panel Reports and received from producing companies and international organizations. The results are presented on a substance-by-substance basis.

CFC-11 and CFC-12

11. The yearly projected Article 5 country demand for CFC-11 decreases from 50,000 tonnes in 1992 to elimination in 2005. The forecast cumulative demand to phase-out is 417,000 tonnes.

12. The yearly projected demand for CFC-12 decreases from 66,000 tonnes in 1992 to 10,000 tonnes at the end of the grace and phase-out period in 2010. The forecast cumulative demand to the year 2010 is 845,000 tonnes.

13. The annual production capacity of Article 5 countries for CFC-11 and CFC-12 is currently

121,000 tonnes. Closure of production facilities in Article 5 countries owned by transnational producers is expected to reduce capacity to 80,000 tonnes in 2000. In 2005, when Article 2A applies to production in Article 5 countries, production will be reduced to 48,000 tonnes and to 20,000 tonnes in 2007. In 2010 production must be zero.

14. The production capacity in Article 5 countries appears to be sufficient to meet these countries' own needs and the needs of other Article 5 countries until the end of the grace and phase-out period, except the year 2007.

15. The actual annual production of Article 5 country producers is currently about 50 percent of production capacity and is generally only for domestic needs. If Article 5 country producers increase their production it could take a few years before distribution channels are developed so that demand from other Article 5 countries can be met from increased production.

16. In 2010 the residual demand for CFC-12 is assumed to be used in the refrigeration sector, especially for recharging domestic refrigerators and automotive air conditioners. This demand is estimated to be 10,000 tonnes. The expected recycled volumes might contribute significantly to meeting this demand. Recycling projects in the Mobile Air Conditioning subsector are in the preliminary stages of implementation. Experience gained through the successful implementation of these projects will provide a more accurate prognosis of the share of recycled CFC to meet required demands. On the basis of the UNEP Technical Options Panel Report on Refrigeration, Air Conditioning and Heat Pumps (1991), it has been assumed that 20 percent of the total recovered volumes of refrigerant from 1994 to 2005 will be in Article 5 countries. After 2005, this proportion could increase up to 50 percent.

CFC-113

17. Based on the information from country programmes, the yearly projected demand in Article 5 countries for CFC-113 decreases from 9,300 tonnes in 1992 to expected elimination by 1999. The forecast cumulative demand before phase-out is 44,000 tonnes.

18. The annual production capacity of Article 5 countries is 2,500 tonnes. The cumulative capacity for 1992 to 1999, the year of complete phase-out of CFC-113, is 16,000 tonnes. This capacity is not sufficient to meet projected demand during the grace and phase-out periods in Article 5 countries. In theory, this shortfall could be met through allowed imports from developed countries, in order to satisfy the basic domestic needs of the Parties operating under paragraph 1 of Article 5, although in practice, capacity in these countries may be eliminated very soon.

Methyl chloroform

19. The yearly projected demand for methyl chloroform decreases from 51,000 tonnes in 1992 to expected elimination by 2005. The cumulative forecast demand until phase-out is 431,000 tonnes.

20. The Article 5 country producers do not have sufficient capacity to meet demand and are therefore dependent on developed country producers for supply. Under Article 2E, these producers may export to Article 5 countries 10 percent of their 1989 production level. This would be sufficient to meet all projected demand in Article 5 countries. However, capacity in developed countries may be eliminated much earlier.

CFC-114 and CFC-115

21. CFC-114 and CFC-115 are used in small quantities in Article 5 countries. The cumulative demand for CFC-114 and CFC-115 from 1992 to expected elimination by 2000 is 12,000 tonnes. There is no specific breakdown available. There seems to be sufficient production capacity in Article 5 countries to meet the projected demand for CFC-114. However, there is no production of CFC-115 in Article 5 countries. CFC-115 is mainly used as a component of low-temperature refrigerant R-502. Their use is assumed to be phased-out in line with developed country schedules. The substitute for R-502 has been developed and will soon be on the market.

Halon-1211 and Halon-1301

22. In 1992, projected demand for Halon-1211 was 6,900 tonnes and for Halon-1301, 900 tonnes. The forecast cumulative demand for halons from 1992 to expected elimination by 2005 is 54,000 tonnes of Halon-1211 and 6,800 tonnes of Halon-1301. The production capacity of Article 5 countries is sufficient to meet all Article 5 countries' projected needs throughout the grace and phase-out periods.

RECOMMENDED METHODS OF MEETING ARTICLE 5 NEEDS

23. For CFC-11, CFC-12, Halon-1211 and Halon-1301, the total existing production capacities in Article 5 countries is greater than projected demand until 2007.

24. If these production capacities are to meet the future demand in Article 5 countries, the existing distribution arrangements, under which companies in Article 5 countries import substances from developed country producers, will have to be replaced by corresponding arrangements with producers in Article 5 countries.

25. Customers for these substances in Article 5 countries may need to be informed of the possibility that, if their existing suppliers cannot meet demand because of the elimination of production capacity, there could be alternative sources of supply from Article 5 countries.

26. In 2007 projected demand for CFC-12 is greater than the allowed production under Article 2A. If recovery and recycling programmes are successfully implemented, there might be sufficient recovered CFC-12 available to meet the projected demand for the servicing of CFC-12 refrigeration equipment, especially domestic refrigerators and mobile air conditioners in 2007 and after 2010. Efforts should be directed at assisting each country to set up recovery, recycling

and storage programmes ahead of 2007 when recovered volumes will be needed.

27. For CFC-115, CFC-113 and methyl chloroform, there appears to be insufficient capacity in Article 5 countries to meet their projected demand. The demands can be met only by export of these substances from industrialized countries.

METHODOLOGY

Study Objectives

1. The Parties to the Montreal Protocol have requested the Executive Committee to consider the needs of Article 5 countries for controlled substances during their grace and phase-out periods, with the following objectives:

- to forecast the demand of Article 5, Paragraph 1 Parties for controlled substances in the years to 2010;
- to assess to what extent this demand can be met by existing production facilities; and,
- to recommend methods of meeting their needs in full.

2. To meet the first objective, data has been collected from various sources to establish the current consumption of controlled substances by Article 5 countries. Stated intentions of individual Parties and justified assumptions are used to develop projections of future consumption. Within the constraints of available data, this analysis has been prepared for each of the controlled substances and for each of the Article 5 countries.

Data Sources

3. In order to forecast future Article 5 country demand for each substance, the following information and estimates have been used:

- current consumption of each substance, to establish a baseline;
- an estimate of growth in consumption;
- a breakdown of consumption by usage, in order to develop an elimination profile;
- stated intentions of individual countries to adopt an accelerated phase-out; and,
- forecasts of usage of controlled substances.

Method of Analysis

4. Current consumption by substance was determined for each country. Future demand was forecast by applying a growth profile and an elimination profile to the base year. Where information was available from country studies and/or country programmes, the growth and

elimination profiles were tailored to each country. Where there was no information available on future usage, the standard elimination profiles were used. These were estimated for each substance reflecting the ease and economic viability of substitution.

5. Demand in year n of substance s is thus D_{ns} such that:

$$D_{ns} = D_i(1+R_n)(1 - E_{ns})$$

where, D_i is the base year consumption;
R_n is the total unconstrained growth in the years i to n; and,
E_{ns} is the projected percentage of most likely reduction in consumption of substances by the end of year n.

6. The data on current consumption is not consistent. Some of the data is from 1989, 1990 and 1991 and occasionally, all three. In each case, the most recent year has been used as the base. To derive a consumption figure for 1991, where data was available only for 1989 or 1990, the figures have been extrapolated forward at the expected growth rate.

7. The method by which values of R_n and E_{ns} for each country was derived depends on the available information. For those countries for which stated phase-out intentions are available, the projection uses this information to determine future demand.

8. The projected demand prepared in this study are thus sensitive to assumptions of growth and elimination of usage. Changing the assumptions used would alter the results obtained.

9. Future production capacity was assumed to be current production capacity reduced by producers' stated ODS elimination plans. During the phase-out period when the Montreal Protocol applies to Article 5 countries, any remaining production by a given producer country is limited to a percentage of 1996 production plus the additional production allowed for export under the terms of the Protocol.

10. It is assumed that non-Article 5 countries will cease their production either in accordance with the terms of the Protocol or earlier. This study is based on the London Amendment to the Montreal Protocol and does not take account of any expected future amendments.

Unconstrained Growth Assumptions

11. Where an estimate of unconstrained growth is available from a country programme, that estimate has been used. Where no information is available, an estimate based on an overall growth in demand of 7 percent per year has been used, varied by likely growth in that country's gross domestic product (GDP) and degree of use of controlled substances. From examination of the country programmes and other sources, 7 percent appears to be a reasonable estimate of growth.

Individual Country Elimination Profiles

12. Certain Article 5 countries have officially stated their intention to adopt developed country phase-out schedules in accordance with the Montreal Protocol. Some of the other Article 5 countries for which country programmes have been prepared have declared a schedule for phase-out which makes use of the grace period allowed them as Article 5 countries. These stated schedules have been used in projecting needs for controlled substances for these countries.

Development of the Standard Elimination Profile

13. Where no information is available from country programmes, a standard elimination profile for each substance is used which is the amount of ODS remaining after the substitution or replacement of equipment.

14. Certain uses of controlled substances can be reduced at little or no additional cost. For these uses, including aerosols, flexible foams and some solvent processes, substitute technologies can be adopted easily by Article 5 countries thus eliminating some consumption of controlled substances. This early elimination will particularly apply to transnational-owned companies and products exported to markets in developed countries. Where domestic markets are subject to international competition, there will also be a trend towards new technologies.

15. The development of these elimination profiles is judgemental and depends on various factors, such as:

- the existence and availability of substitutes for ODS;
- the availability of alternative non-ODS technology and information on applications of this technology;
- the costs of conversion for the end user;
- the export potential of Article 5 countries;
- the extent to which, for non-producer countries, supply of ODS is constrained; and,
- the extent to which price trends render use of ODS uneconomic.

16. The elimination profiles have been developed through: discussions with informed sources including producers, consideration of the above factors, and examination of country programmes and recent papers on ODS use.

17. The profiles for each sector are described in the following sections together with the results of the analysis.

REFRIGERANTS, FOAMS AND AEROSOLS

18. This section considers the current consumption and projected demand for and expected supply of CFC-11 and CFC-12 in the Article 5 countries. The production capacity of the Article 5 countries is considered and compared with projected demand to derive the capacity difference (excess or shortfall) annually to 2010.

19. CFC-11 and CFC-12 are widely used in Article 5 countries in the production and servicing of refrigeration equipment, in foam blowing and as aerosol propellants.

Assumptions

20. The elimination profiles for CFC-11 and CFC-12 were developed initially by considering usage sectors, namely refrigeration, foams, and aerosols. These profiles by usage were then converted into profiles for CFC-11 and CFC-12, using average figures.

21. Figure 1 shows the elimination profiles. The assumptions on which these profiles were derived are described below.

Refrigerants

22. Demand for CFCs for refrigeration and air conditioning is primarily the result of the production of new equipment and recharging and servicing of existing equipment. In less developed countries, equipment lifetimes tend to be much longer. Thus, recharge demand is higher and lasts longer than in the developed world. New refrigerators are assumed to be recharged five years after purchase and may be recharged several times during the refrigerator's lifetime of approximately 20 years. The growth in recharge demand thus lags the growth in the refrigerator population: typically recharge demand will continue for 20 years after production of CFC equipment has ceased.

23. CFC refrigerators will be replaced by HFC refrigerators in developed countries which is expected to result in an increased supply of second hand CFC refrigerators to Article 5 countries. Manfacturers of refrigerators in Article 5 countries may start to convert to HFC refrigerators from 1996 but due to the expected influx of second hand equipment there is not expected to be any decrease in the CFC refrigerator population until after 2002.

24. It is assumed that 20 percent of the unconstrained demand for refrigerants will be eliminated by 1996. Their use in industrial applications will be completely eliminated in 2000, and in commercial applications by 2010. About 10 million CFC-based air-conditioned vehicles will be in service in Article 5 countries in 2010 and approximately one-third of these vehicles will require servicing annually thereafter. Forty five percent of 1996 forecast demand for use in domestic refrigeration will remain in 2010.

25. CFC-114 and CFC-115 are used in small quantities. Their use is assumed to be phased-out in line with the developed countries. A substitute for CFC-115 has been developed and will soon be on the market.

Aerosols

26. Most of the products which are currently dispensed by aerosols with CFC-11 and CFC-12 propellant can be dispensed easily and economically by other means. Other chemicals can be used as substitute propellants. An exception is metered dose inhalants for which CFCs are currently considered essential. However, research is progressing and a substitute is expected. Several Article 5 countries have implemented initiatives to curtail CFC use in aerosols. The elimination profile shows a 50 percent elimination by 1994 and complete elimination by 1997.

Foams

27. Foams which use CFCs as blowing agents are classified as flexible, semi-rigid and rigid. Substitutes are readily available for production of flexible foams and approximately 50 percent of total foam usage could be eliminated by 1997. For rigid foams, technology is available to reduce CFC content. However, there are no proven alternatives available in insulation foams for refrigeration and use is assumed to continue until 2005.

Consumption by Article 5 Countries in 1991

28. In 1991, the estimated total consumption of CFC-11 and CFC-12 by the Article 5 countries was 111,626 metric tonnes of which CFC-11 accounted for 48,025 metric tonnes and CFC-12, 63,601 metric tonnes.

29. Of this total consumption, 69 percent was domestic consumption in producer countries. Each of the producer countries has sufficient production capacity to satisfy domestic demand but, in 1991, actual production by some of the producer countries was well below capacity and CFCs were also imported for domestic use.

30. The non-producer countries had total estimated consumption of 37,227 metric tonnes. CFCs were imported from developed countries and other Article 5 country producers.

31. Article 5 consumption was 18 percent of total world production for 1991, (463,866 tonnes) as reported in the Alternative Flurocarbons Environmental Acceptability Study (AFEAS). The study indicates that there may be an additional 163,325 tonnes of unreported production.

Forecast Demand

32. Applying the methodology described above to the data collected, projections of Article 5 country needs have been derived. The calculated demand of all Article 5 countries for CFC-11

and CFC-12 is displayed in Table 1 and graphically in Figure 2. Total forecast ODS demand is shown in Figure 3.

33. The yearly projected Article 5 countries demand for CFC-11 decreases from 50,000 tonnes in 1992 to complete elimination by 2005. The total projected demand to phase-out is 417,000 tonnes.

34. The yearly projected demand for CFC-12 decreases from 66,000 tonnes in 1992 to 10,000 tonnes at the end of the grace and phase-out periods in 2010. The total projected demand to 2010 is 845,000 tonnes.

35. Demand for CFC-12 for recharge and servicing of existing refrigeration equipment and automotive air conditioners is expected to continue. Demand for CFC-12, therefore, does not fall below 50,000 tonnes until 2001 and gradually decreases to 10,000 tonnes in 2010.

Production Capacity

36. Production capacity is the maximum possible output of existing plants. CFC-11 and CFC-12 are being produced in six of the Article 5 countries. These two substances are manufactured by the same plant which is capable of switching production from one to the other to meet demand. The same plant can also be converted, in some cases, to produce HCFC-22.

37. The annual production capacity of the Article 5 countries for CFC-11 and CFC-12 is currently 121,000 tonnes with 1991 output estimated at 61,000 tonnes. Planned elimination of production facilities in Article 5 countries owned by transnational producers is expected to reduce capacity to 80,000 tonnes in 2000.

38. Article 2A of the Montreal Protocol restricts Article 5 country consumption of CFCs in 2005 to 50 percent of base-year levels and to 15 percent of base-year levels in 2007, with complete phase-out in 2010. Further, production for export cannot be more than 10 percent of base-year production after 2005. Production is, therefore, restricted to 48,000 tonnes in 2005 and to 20,000 tonnes in 2007. In 2010 production must be zero. (Note: the base-year levels referred to in this paragraph are average annual consumption levels from 1995 to 1997 or a calculated level of consumption of 0.3 kg. per capita, whichever is the lower amount).

Methods of Meeting Needs

39. From this analysis, there is estimated to be an excess of production capacity in the Article 5 countries until 2010 with the exception of 2007 when there is a slight shortfall (see Figure 2). Therefore, Article 5 producers could increase production to satisfy demand for CFC-11 and CFC-12 in all the Article 5 countries.

40. Table 2 shows the quantities of CFCs developed countries are allowed to produce between 1995 and 2000 under the terms of the Montreal Protocol for export to Article 5 countries. Should Article 5 producers be unable to meet the needs of other Article 5 countries,

the export volumes allowed to developed country producers are clearly sufficient to meet the shortfall. The economic viability of producing small quantities for export and the intentions of developed world producers to shut down ahead of the Montreal Protocol schedule will determine the extent of supply from the developed world.

41. In the 1991 UNEP study "Technical Options Report on Refrigeration, Air Conditioning and Heat Pumps", total world recovered amounts of CFCs are estimated to be 10,000 tonnes in 1991 increasing to 17,000 tonnes in 1997 then decreasing. It is assumed that by 2005, 20 percent of the total estimated recovered quantities will be within Article 5 countries. After 2005, this proportion is assumed to increase. If recycling programmes in Article 5 countries are successful, the expected recycled volumes might contribute significantly to meet demand in 2010 when approximately 10,000 tonnes will be required.

CFC-114 and CFC-115

42. Total consumption in Article 5 countries in 1991 was less than 1,000 tonnes each of CFC-114 and CFC-115. The cumulative demand for CFC-114 and CFC-115 from 1992 to expected elimination by 2000 is 12,000 tonnes. CFC-114 is used in small quantities in air conditioning, heat pumps, and in foam blowing. CFC-115 is used with HCFC-22 in refrigerant R502 for low temperature refrigeration.

43. CFC-114 is produced in one Article 5 country. The quantities produced and the production capacity are not known exactly. Production is estimated at less than 1,000 tonnes per annum and the plant will probably be shut down in 1996.

44. CFC-115 is not produced in Article 5 countries. Demand must be met by imports from developed countries while production continues or by recycling R502. A substitute for R502 has been developed and will soon be on the market.

45. In 1990, AFEAS reported world production of CFC-114 to be 7,969 tonnes and CFC-115, 10,046 tonnes.

46. The timing and extent of the shortfall in supply of CFC-114 and CFC-115 depends on the extent to which production in the developed countries is phased-out. The supply constraints on these substances may force early substitution and replacement of equipment.

SOLVENTS

47. CFC-113, methyl chloroform and carbon tetrachloride are used as solvents. CFC-113 is primarily used in the electronics industry and for precision cleaning. Methyl chloroform is more widely used for metal cleaning. The consumption of carbon tetrachloride is insubstantial. For this reason, it is not considered in this analysis.

Assumptions

48. Conservation and recycling measures can be introduced to reduce demand. However, the amount of solvents that could be conserved and recycled has not been quantified due to the lack of experience in solvent conservation and recycling. Substitutes are available or are under development for most processes. CFC-113 is used in industries such as electronics, which is dominated by transnational corporations, and in the production of goods primarily used for export. Consequently, phase-out is likely to occur in line with developed country schedules. Elimination of CFC-113 is assumed to occur by 1999 in Article 5 countries.

49. Methyl chloroform is used more widely in Article 5 countries than CFC-113. It is used most often in less sophisticated processes and industries. For most applications, there are substitute solvents or processes, but due to wider and more fragmented use, elimination will be slower than for CFC-113. It is assumed that use will be completely eliminated by 2005.

50. Estimated elimination profiles for solvents are shown in Figure 4.

Consumption by Article 5 Countries in 1991

51. In 1991, consumption of CFC-113 was 8,600 tonnes and was concentrated in a few countries.

52. Methyl chloroform is more widely used in developing countries. The Hydrogenated Solvents Industry Alliance (HSIA) estimates developing country consumption of methyl chloroform in 1989 was 69,525 tonnes of which 47,500 was consumed by the Article 5 countries.

Forecast Demand

53. The result of this analysis is that the yearly projected demand in Article 5 countries for CFC-113 decreases from 9,450 tonnes in 1993 to expected elimination by 1999. The total projected demand before phase-out is 44,000 tonnes. Forecast demand is shown in Table 3 and Figure 5.

54. The yearly projected demand for methyl chloroform decreases from 51,000 tonnes in 1992 to expected elimination by 2005. The total projected demand until phase-out is 431,000 tonnes. Forecast demand is shown in Table 3 and Figure 6.

Production Capacity

55. World production of CFC-113 in 1990 reported in AFEAS was 174,801 with the possibility of an estimated 23,625 tonnes of unreported production. CFC-113 is produced in Article 5 countries but production capacity is not known exactly. The annual estimated production capacity in Article 5 countries is 2,500 tonnes. The cumulative capacity for the period from 1992-1997, the year of complete phase-out of CFC-113, is 16,000 tonnes.

56. There is still some methyl chloroform produced in Article 5 countries but the production capacities are small and not known exactly. World production in 1991 was approximately 700,000 tonnes.

Methods of Meeting Needs

57. On the basis of the estimates Article 5 producers do not have sufficient production capacity for CFC-113 from 1994 to 1999 to supply Article 5 country demand. Figure 5 shows forecast demand and production capacity.

58. CFC-113 will continue to be produced in developed countries and possibly by Article 5 producers as a feedstock for HFC-134a which is a substitute substance. Under the terms of the Protocol, developed country producers would be able to continue to supply up to 10 percent of 1986 production to meet essential needs of Article 5 countries.

59. There is a small production capacity of methyl chloroform in Article 5 countries. Article 5 countries are therefore dependant on the developed country producers for supply. Under Article 2E of the Protocol, non-Article 5 producers may export to Article 5 countries 10 percent of their 1989 production up to 2010. If production continues, this would be sufficient to meet all projected demand in Article 5 countries. Figure 6 shows forecast demand and production capacity.

Carbon tetrachloride

60. The data received on consumption of carbon tetrachloride is incomplete. The country programmes indicate total consumption of carbon tetrachloride in Article 5 countries 1991 of only 564 tonnes.

61. It has been assumed that consumption will be eliminated in 2004. The elimination profile used is the same as that for methyl chloroform.

62. Carbon tetrachloride is produced as a feedstock for production of CFCs. The data available does not allow non-feedstock production to be separated from feedstock production.

63. Supply is expected to be sufficient for the small quantities required by Article 5 countries.

HALONS

Assumptions

64. Halons are mostly used in fire protection. The high ODP weighting of halons has made them subject to early reduction by substitution, recycling and conservation efforts. Essential uses could be as little as 20 percent of current applications. Halons stored in halon equipment recalled from non-essential uses can be recovered, banked and used to replace production for essential

uses until a substitute is developed.

65. For Article 5 countries the estimated halon elimination profile eliminates 20 percent of halon use by 1995 and 80 percent of use by 2000 with complete phase-out by 2005. This is shown in Figure 7.

Consumption by Article 5 Countries in 1991

66. In 1991, consumption of Halon-1211 by Article 5 countries was 6,285 tonnes and of Halon-1301 was 825 tonnes.

Forecast Demand

67. The total projected demand for halons from 1992 to expected elimination in 2005 is 54,000 tonnes of Halon-1211 and 6,800 tonnes of Halon-1301. Forecast demand shown in Table 4 and Figure 8.

Production Capacity

68. Halons are produced in two Article 5 countries which have a total production capacity of 16,000 tonnes annually. This production capacity is sufficient to meet all Article 5 countries projected needs throughout the grace and phase-out periods.

CONCLUSION

69. On the basis of assumptions made in this study, Article 5 countries have sufficient production capacity to meet the expected demand for CFC-11, CFC-12, CFC-113 and halons during the ten year grace period allowed under the Montreal Protocol.

70. Output of the Article 5 producers is currently well below production capacity. If production for export were significantly increased over that required to satisfy domestic demand in producer countries, then Article 5 needs could be met up to 2010 except for a slight shortfall in 2007 for CFC-12.

71. Supply at this level would, however, require development of the necessary distribution channels between producer and non-producer Article 5 countries, and the enforcement of domestic control measures to ensure that additional production for export is actually exported.

72. The terms of the Montreal Protocol, as they apply to developed countries, allow limited additional production for export to Article 5 countries during their grace and phaseout periods. For all controlled substances, the allowed export volumes would be sufficient to cover any shortfall between expected demand and Article 5 production. However, several developed country producer companies have anounced their intentions to shut down production ahead of the allowed dates. The allowed production for export from non-Article 5 countries may not be made available if the small volumes required by Article 5 countries cannot be viably produced.

73. Recovery and recycling could supplement Article 5 production of CFC-12. The estimated recoverable volumes might absorb the shortfall in 2007. Recoverable volumes might contribute significantly to meeting projected demand until 2010.

74. It is expected that Article 5 country producers will be unable to supply amounts of methyl chloroform required to meet expected demand.

75. In the final analysis, the degree to which demand for ODS will be met in Article 5 countries depends on:

- the economic viability of production of small quantities of controlled substances;
- local regulations limiting production of controlled substances in producer countries;
- the establishment of recovery and recycling programmes, and
- the establishment of distribution channels between Article 5 producers and other Article 5 countries.

PROJECTED DEMAND FOR CFC–11 AND CFC–12 IN ARTICLE 5 PARTIES

TABLE 1

(METRIC TONNES, UNWEIGHTED)

YEARS 1991 – 2000		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CFC–11	Annual	48,025	50,275	48,871	46,816	43,315	39,117	34,145	32,885	31,428	27,586
	Cumulative		50,275	99,146	145,962	189,277	228,394	262,539	295,424	326,852	354,438
CFC–12	Annual	63,601	66,363	67,254	65,967	63,999	61,426	57,925	57,421	55,452	51,825
	Cumulative		66,363	133,617	199,584	263,582	325,008	382,933	440,354	495,807	547,631
CFC–11 & CFC–12		111,626	116,638	116,125	112,783	107,314	100,543	92,071	90,306	86,880	79,410
	Cumulative		116,638	232,763	345,546	452,859	553,402	645,472	735,779	822,659	902,069

YEARS 2001 – 2010		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CFC–11	Annual	23,575	18,664	12,725	7,957	0	0	0	0	0	0
	Cumulative	378,012	396,677	409,402	417,359						
CFC–12	Annual	48,565	44,374	40,160	35,934	30,467	27,937	24,783	19,869	15,340	10,155
	Cumulative	596,197	640,570	680,731	716,665	747,132	775,069	799,852	819,721	835,060	845,215
CFC–11 & CFC–12		72,140	63,038	52,886	43,891	30,467	27,937	24,783	19,869	15,340	10,155
	Cumulative	974,209	1,037,247	1,090,133	1,134,023	1,164,490	1,192,427	1,217,210	1,237,079	1,252,419	1,262,574

TABLE 2

DEVELOPED WORLD PRODUCTION FOR EXPORT TO ARTICLE 5 PARTIES ALLOWED UNDER THE TERMS OF THE MONTREAL PROTOCOL

	TOTAL REPORTED WORLD PRODUCTION 1986 SOURCE: AFEAS	ESTIMATED DEVELOPED COUNTRIES PRODUCTION 1986	ADDITIONAL PRODUCTION FOR EXPORT TO ARTICLE 5 1995 – 2000 An additional 10% of 1986 production may be produced for export to Article 5 countries
CFC–11	350,148	305,148	30,515
CFC–12	398,363	353,363	35,336
CFC–113	196,614	194,114	19,411
CFC–114	19,101	19,101	1,910
CFC–115	11,818	11,818	1,182

PROJECTED DEMAND FOR SOLVENTS IN ARTICLE 5 PARTIES

TABLE 3

(METRIC TONNES, UNWEIGHTED)

YEARS 1991 – 2000		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CFC–113	Annual	8,601	9,272	9,451	8,385	6,835	5,153	3,294	1,706	0	0
	Cumulative		9,272	18,723	27,108	33,943	39,096	42,390	44,096		
METHYL CHLOROFORM	Annual	48,081	51,430	49,992	47,266	43,801	39,458	37,887	36,746	31,027	24,267
	Cumulative		51,430	101,422	148,688	192,489	231,947	269,833	306,580	337,607	361,874
CARBON TETRACHLORIDE	Annual	573	580	538	457	346	199	197	194	190	185
	Cumulative		580	1,118	1,574	1,920	2,119	2,317	2,510	2,700	2,885
YEARS 2001 – 2010		**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CFC–113	Annual	0	0	0	0	0	0	0	0	0	0
	Cumulative										
METHYL CHLOROFORM	Annual	22,986	21,983	15,865	8,589	0	0	0	0	0	0
	Cumulative	384,859	406,842	422,707	431,296						
CARBON TETRACHLORIDE	Annual	177	310	224	121	0	0	0	0	0	0
	Cumulative	3,062	3,373	3,597	3,718						

PROJECTED DEMAND FOR HALONS IN ARTICLE 5 PARTIES

TABLE 4

(METRIC TONNES, UNWEIGHTED)

YEARS 1991 – 2000		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
HALON 1211	Annual	6,285	6,869	6,783	6,478	6,162	5,727	5,158	4,526	3,695	2,608
	Cumulative		6,869	13,652	20,130	26,292	32,018	37,177	41,703	45,398	48,006
HALON 1301	Annual	825	936	915	863	802	722	621	543	435	294
	Cumulative		936	1,850	2,714	3,516	4,238	4,859	5,402	5,837	6,132
TOTAL HALONS	Annual	7,110	7,805	7,698	7,341	6,964	6,448	5,779	5,069	4,130	2,903
	Cumulative		7,805	15,503	22,844	29,808	36,257	42,036	47,105	51,235	54,137

YEARS 2001 – 2010		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
HALON 1211	Annual	2,190	1,797	1,316	723	0	0	0	0	0	0
	Cumulative	50,196	51,993	53,309	54,033						
HALON 1301	Annual	243	199	145	80	0	0	0	0	0	0
	Cumulative	6,374	6,573	6,718	6,798						
TOTAL HALONS	Annual	2,433	1,995	1,462	803	0	0	0	0	0	0
	Cumulative	56,570	58,566	60,027	60,830						

Figure 1

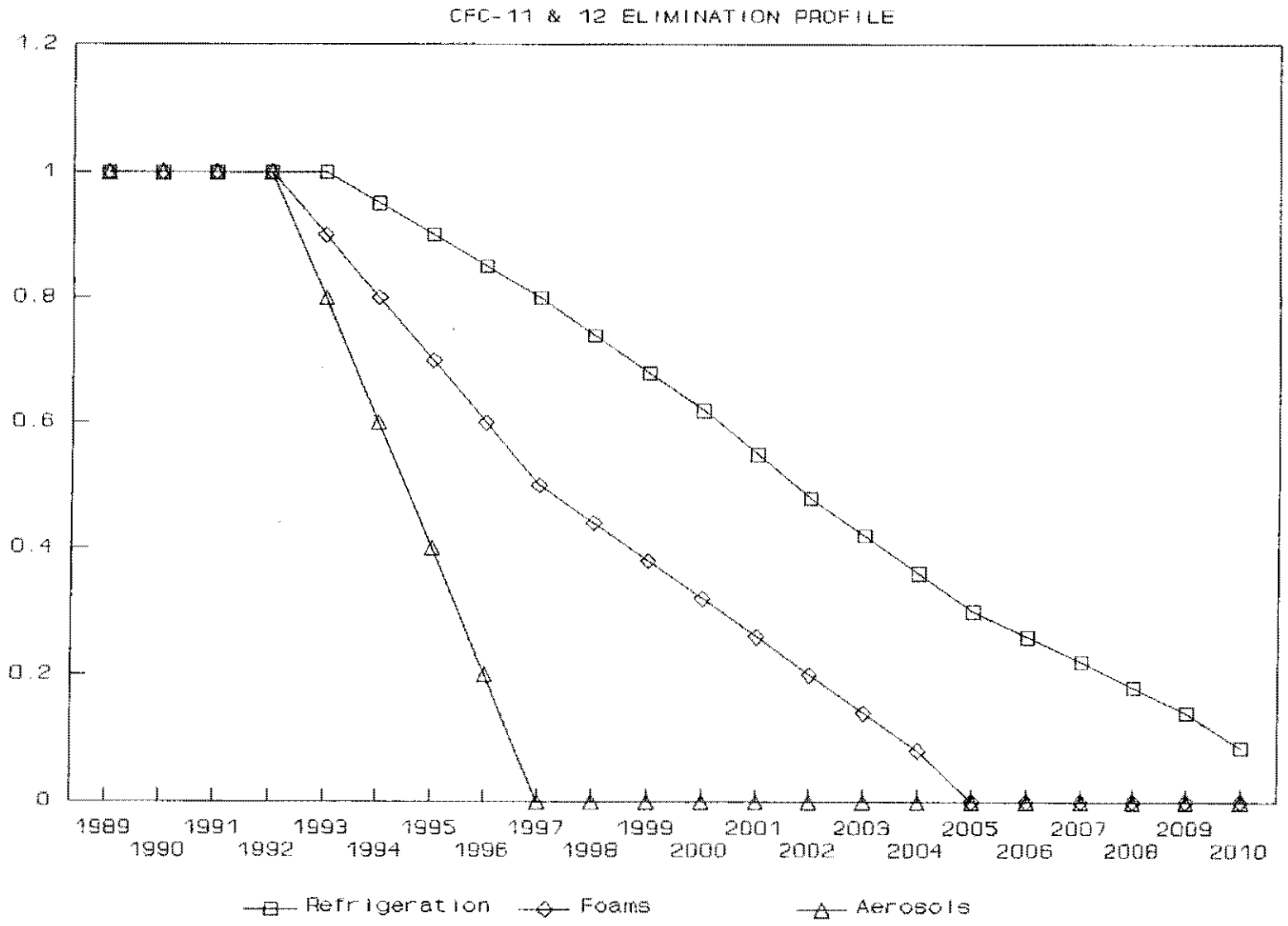

CFC-11 & 12 ELIMINATION PROFILE
1.2
1
0.8
0.6
0.4
0.2
0
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Refrigeration
Foams
Aerosols

Figure 2

Article 5 Production Capacity and Demand of CFC-11 and CFC-12

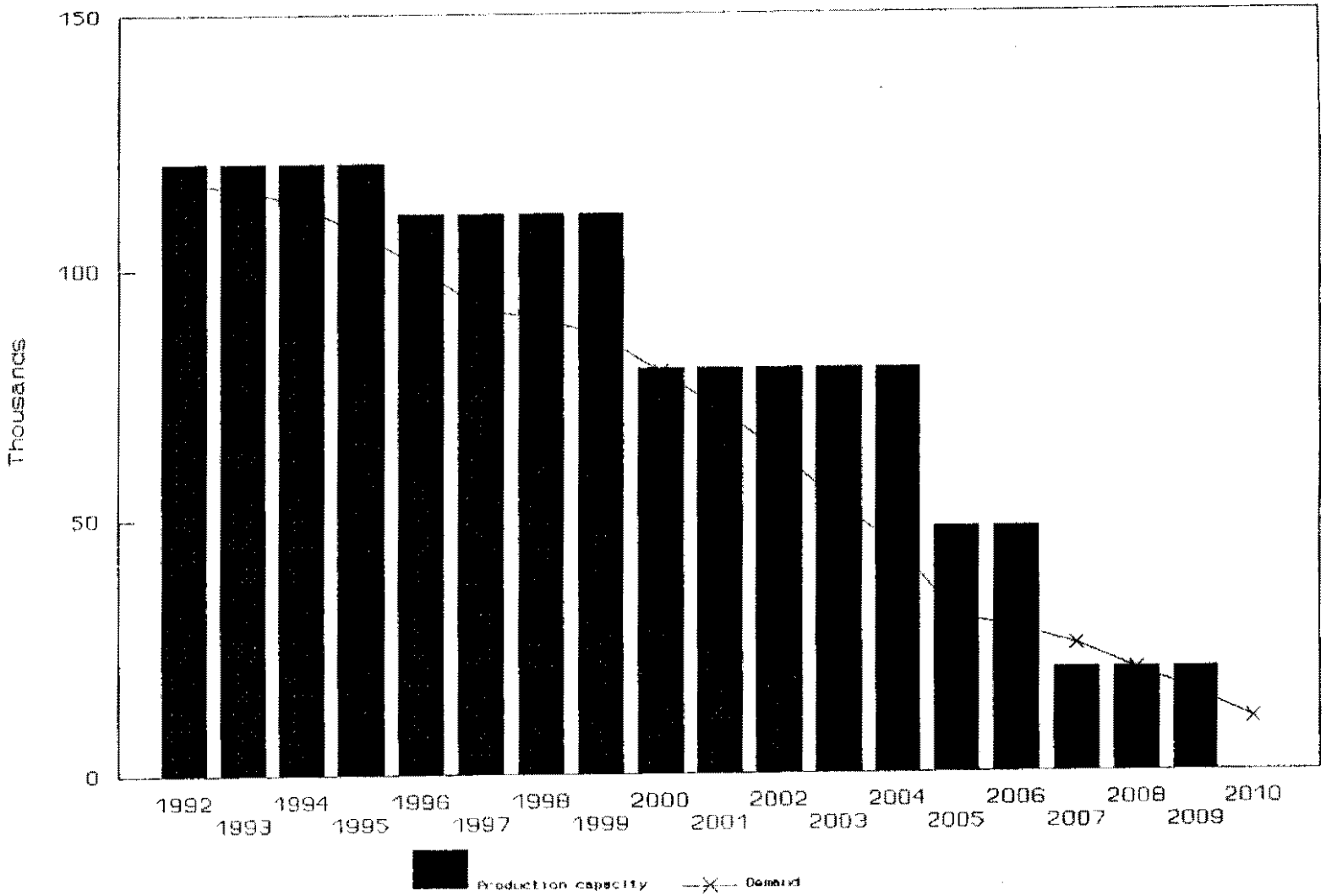


Figure 3

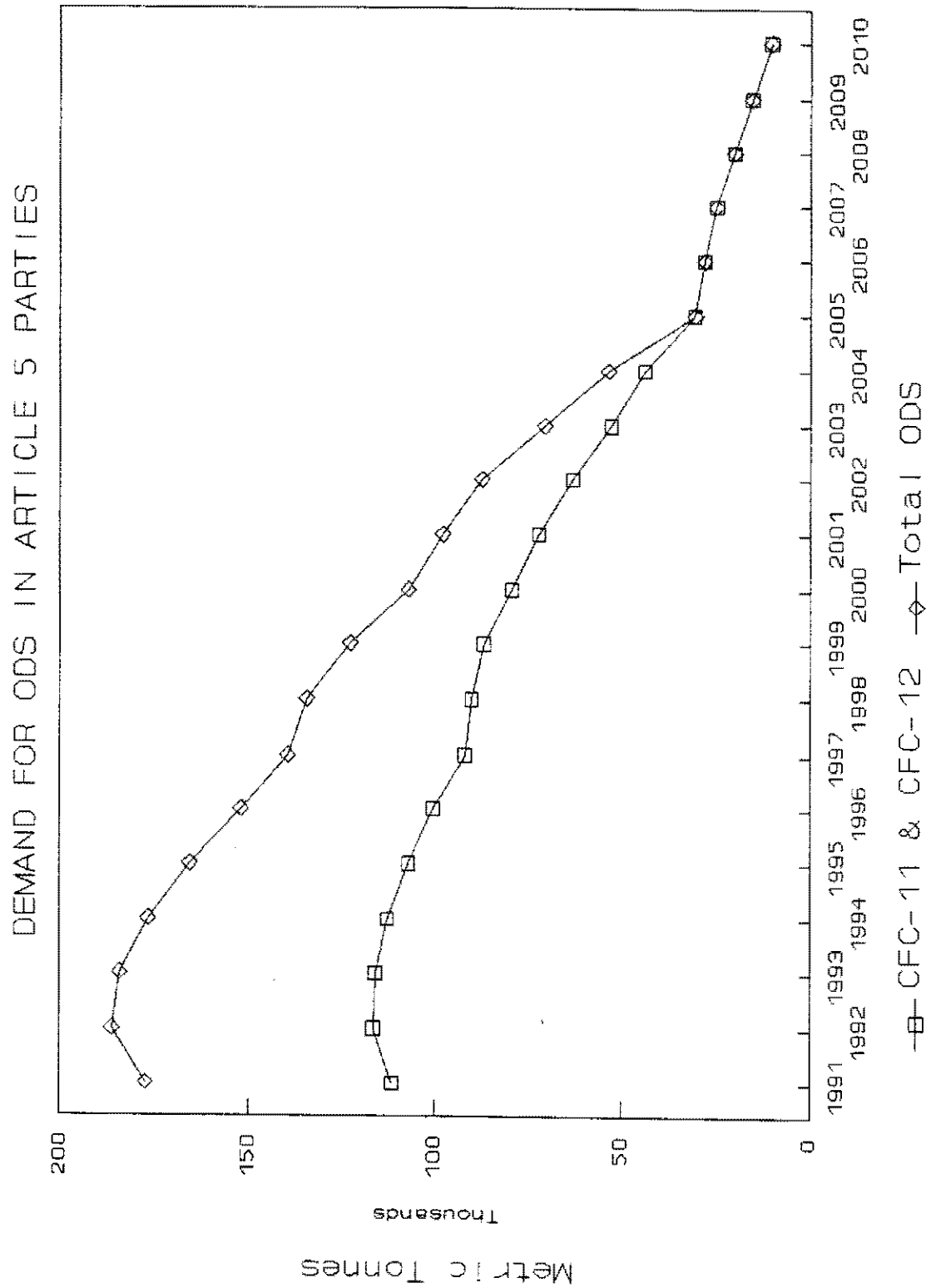

DEMAND FOR ODS IN ARTICLE 5 PARTIES
Metric Tonnes
Thousands
200
150
100
50
0
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
CFC-11 & CFC-12
Total ODS

Figure 4

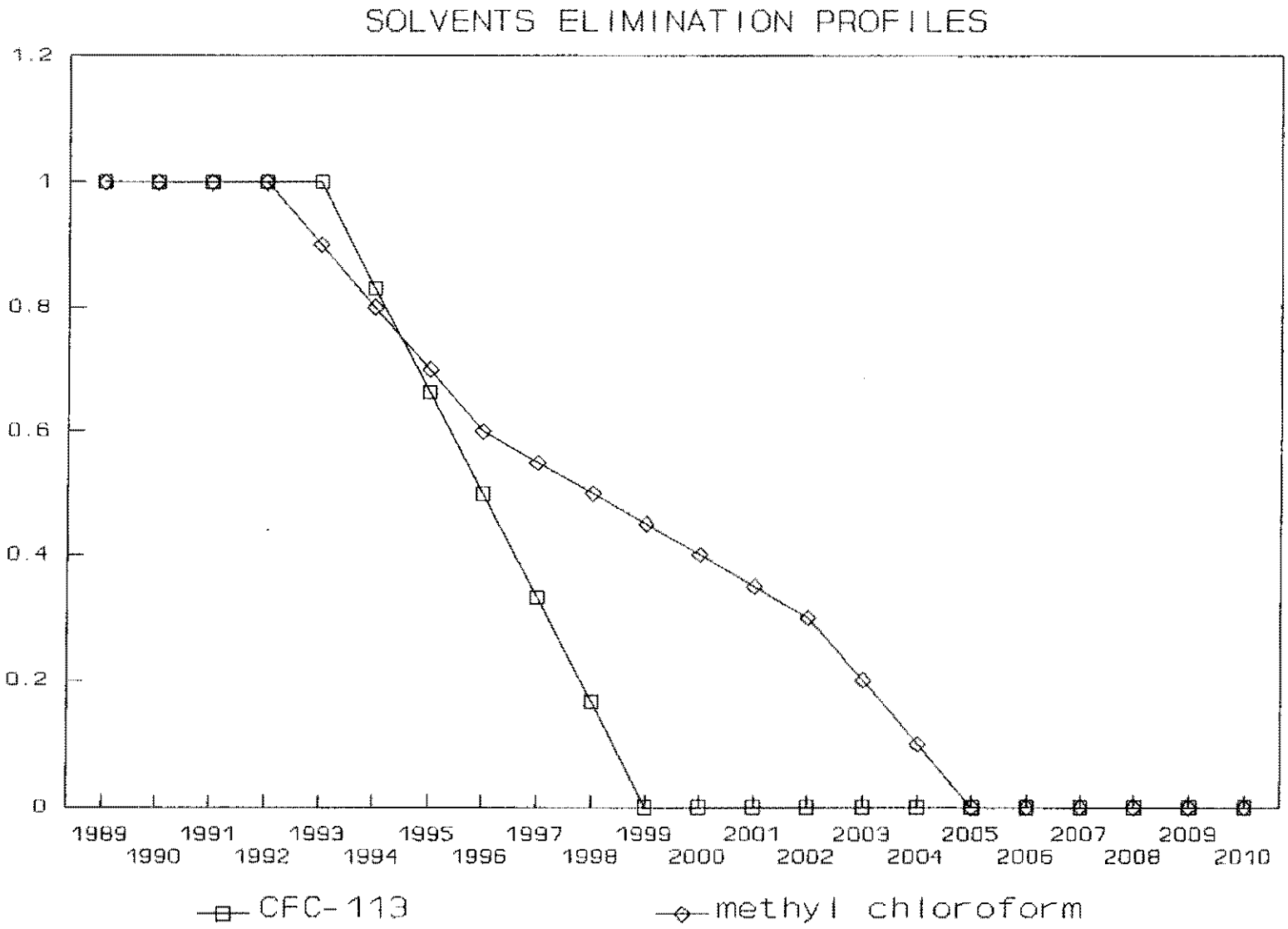

SOLVENTS ELIMINATION PROFILES
1.2
1
0.8
0.6
0.4
0.2
0
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
CFC-113
methyl chloroform

Figure 5

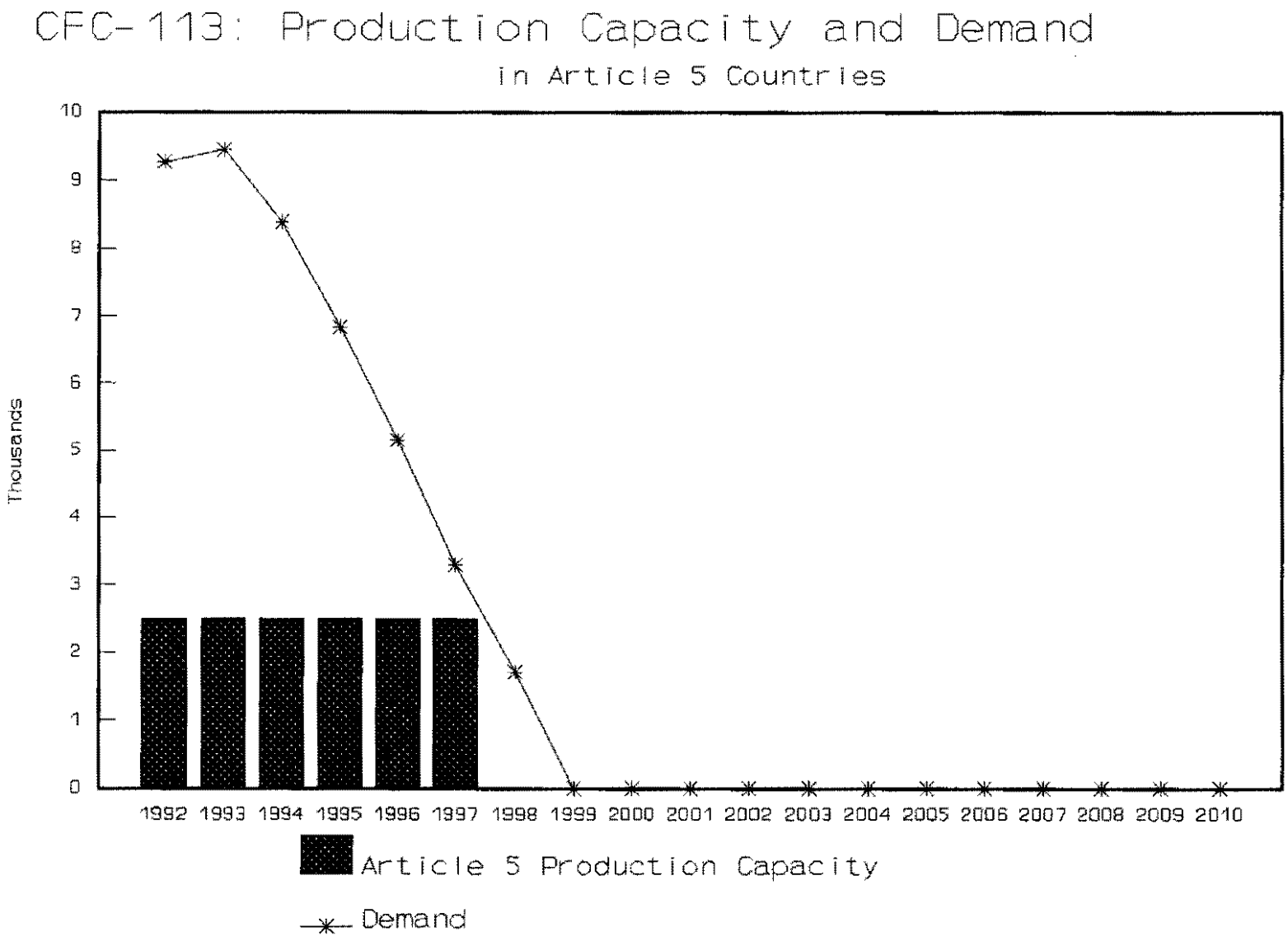

CFC-113: Production Capacity and Demand
in Article 5 Countries
Thousands
10
9
8
7
6
5
4
3
2
1
0
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Article 5 Production Capacity
Demand

Figure 6

Methyl chloroform: Production Capacity and Demand

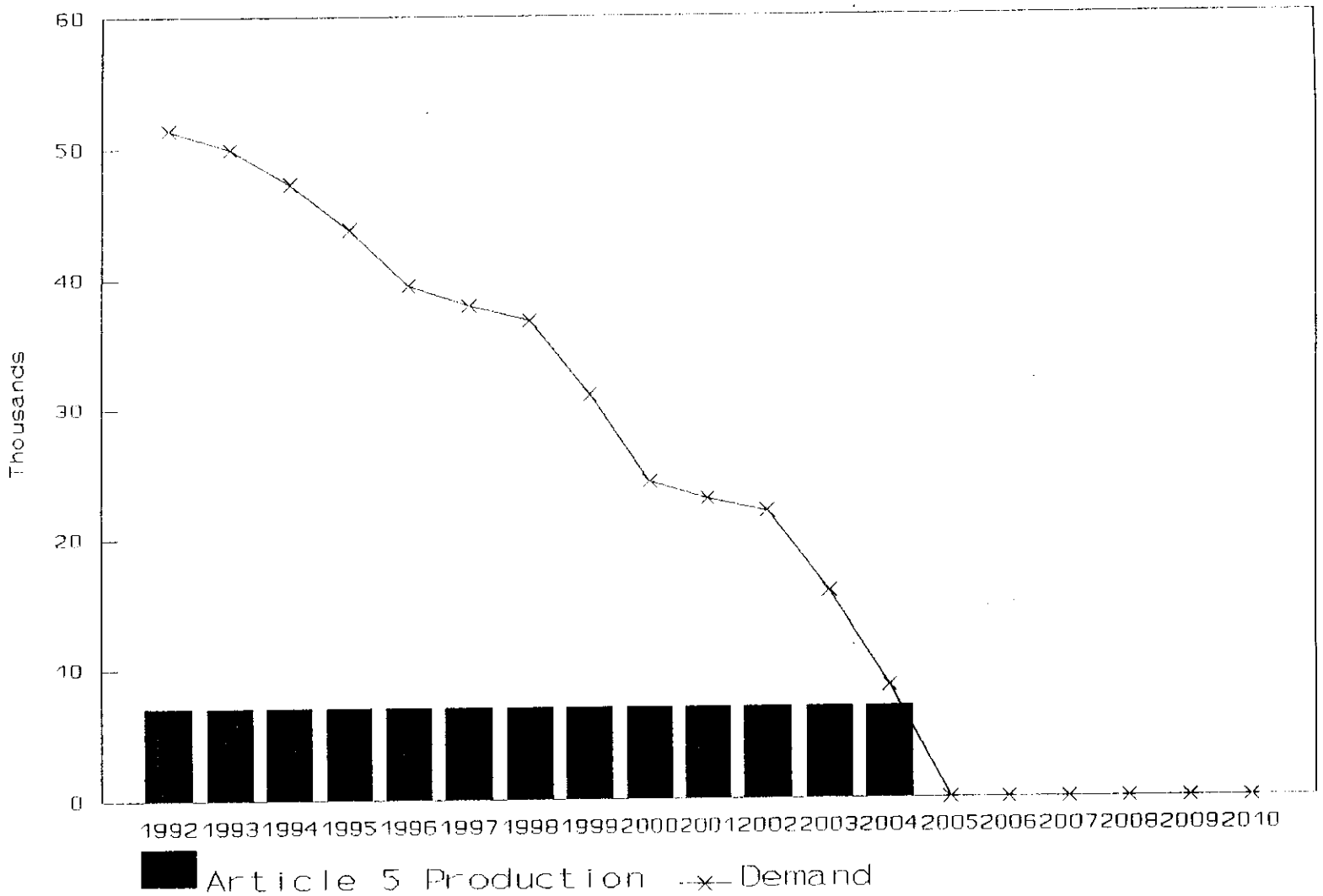


Figure 7

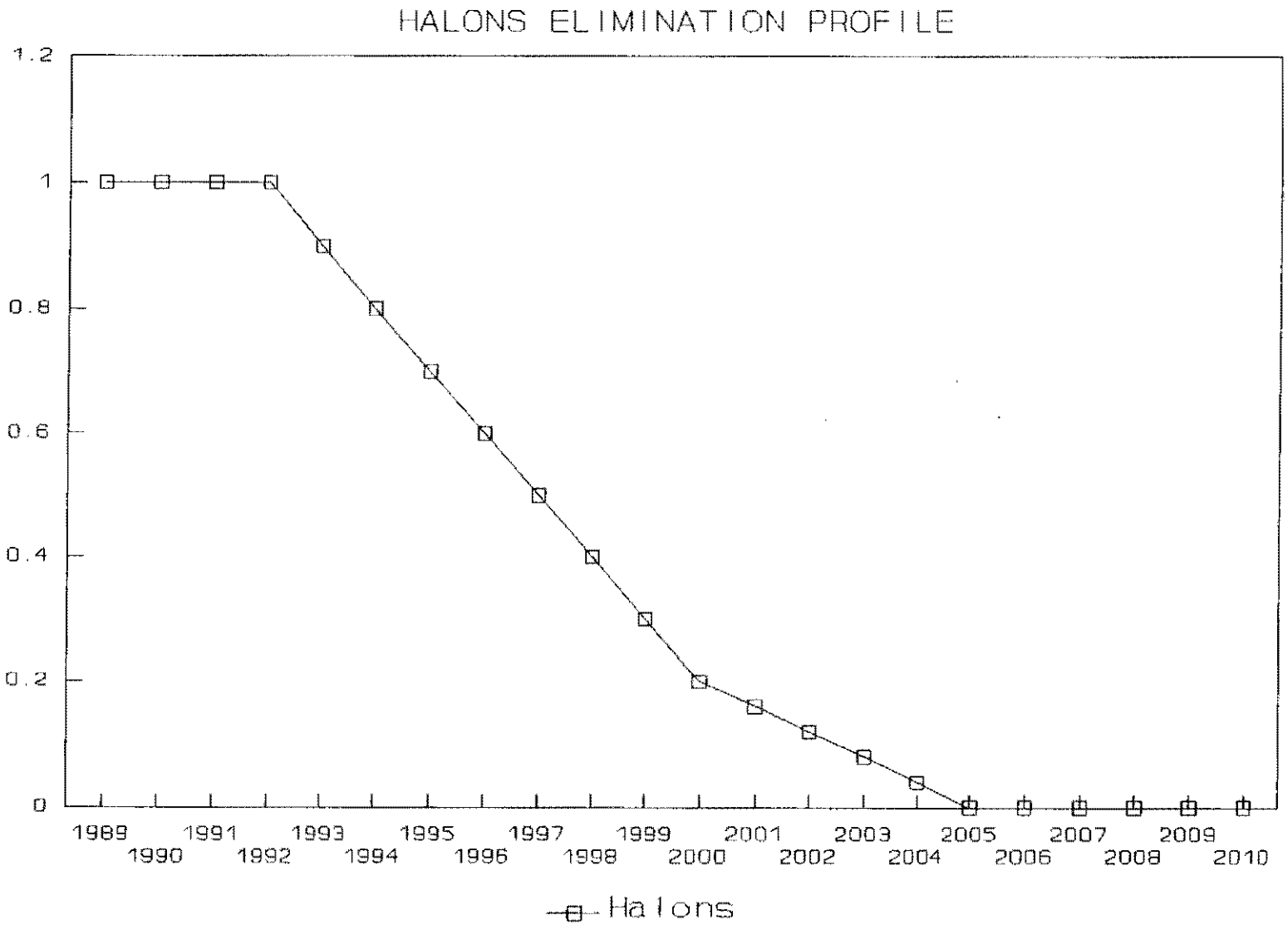
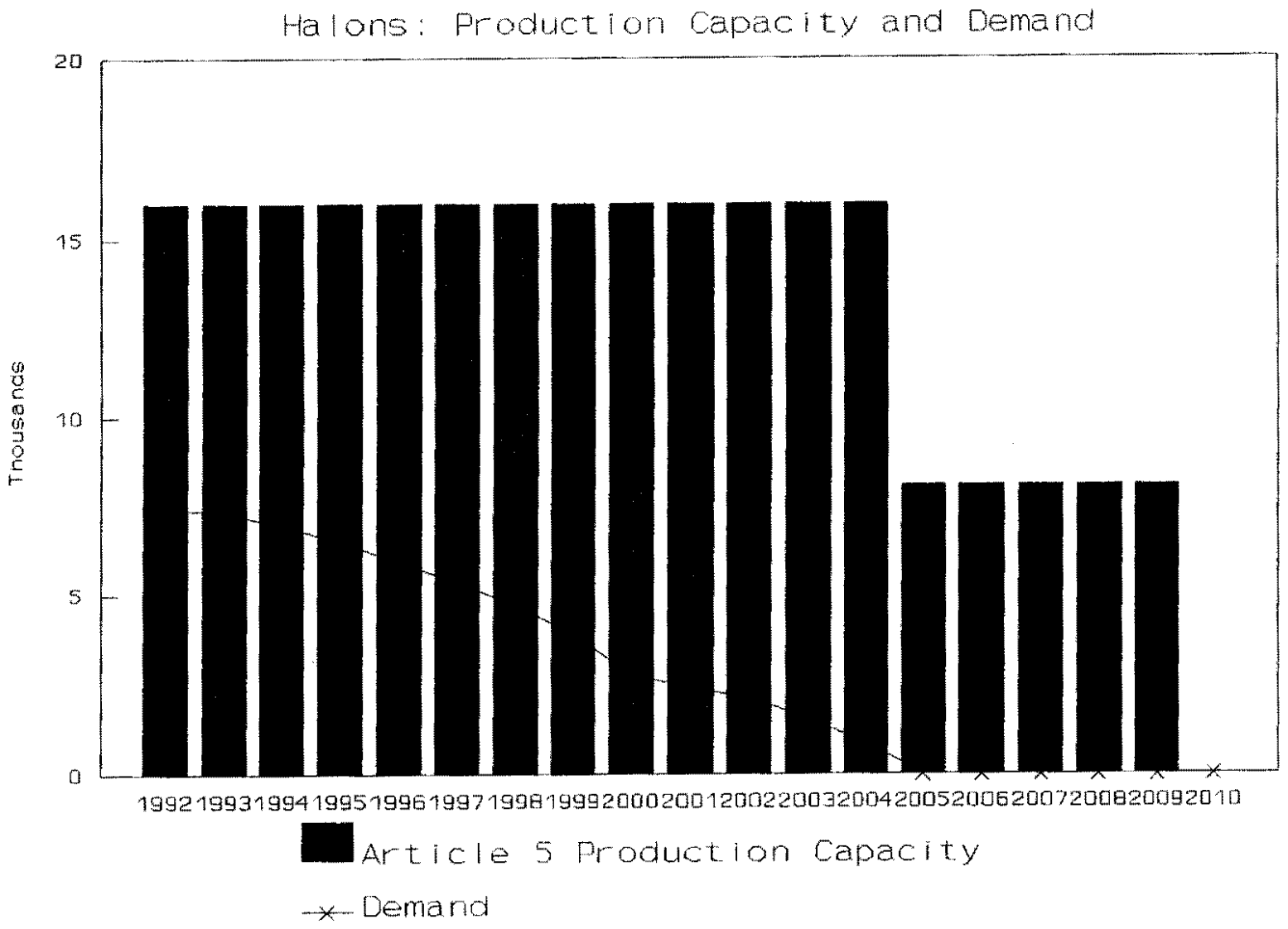

HALONS ELIMINATION PROFILE
1.2
1
0.8
0.6
0.4
0.2
0
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Halons

Figure 8


Halons: Production Capacity and Demand
Thousands
20
15
10
5
0
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Article 5 Production Capacity
Demand