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TOWARDS AN OZONE CONVENTION : A LOOK AT SOME ISSUES

Paper prepared

by

the UNEP Secretariat

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Introduction

1. The purpose of the document is to provide background information on the steps that have led to the convening of an ad hoc working group of legal and technical experts to develop a framework convention for the protection of the ozone layer.

2. The document provides a brief, simplified description of the ozone layer problem for those who are not familiar with the technical considerations involved.

3. The document reviews the issues that need consideration in the development of a framework convention. The information reviewed includes an outline of recent trends in the production, emission and use of potential ozone-depleting substances, and the development and use of substitute chemicals and alternative technology. The socio-economic implications of control measures are noted, and the options for regulatory measures, including the idea of a convention, are briefly discussed.

I. THE UNEP PROGRAMME IN OZONE ASSESSMENT

4. The threat to the ozone layer is a global problem. In response to the potential threat posed by the emission of chemical substances that could, through catalytic action, deplete the stratospheric ozone layer, UNEP convened a meeting of experts designated by Governments, intergovernmental and non-governmental organizations on the ozone layer in Washington in March 1977. The meeting produced a World Plan of Action on the Ozone Layer to be implemented by United Nations bodies, specialized agencies, international, regional, intergovernmental and non-governmental organizations and scientific institutions.

5. With respect to the Plan, UNEP has a broad co-ordinating and catalytic role, aimed at the integration and co-ordination of research efforts. Its task is to arrange for:

(a) Collation and dissemination of information on on-going and planned research activities;

(b) Presentation and review of the results of research;

(c) Identification of further research needs;

(d) Appropriate encouragement of such research.

6. In order for UNEP to fulfil this responsibility, it has established a Co-ordinating Committee on the Ozone Layer (CCOL) composed of representatives of the agencies and non-governmental organizations participating in the implementation of the Plan of Action. The CCOL meets regularly (usually once a year) to make an environmental assessment of ozone layer depletion and its impacts. This assessment is published, together with data on world production and release of chlorofluorocarbons 11 and 12, in the UNEP Ozone Layer Bulletin.

7 The members of the CCOL are Australia, Canada, Denmark, France, Federal Republic of Germany, India, Italy, Japan, Kenya, Netherlands,

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Norway, Sweden, Union of Soviet Socialist Republics, United Kingdom of Great Britain and Northern Ireland, United States of America, Venezuela, UN/ESA, WHO, ICAO, WMO, UNEP, EEC, OECD, CMEA, ICSU and the Chemical Manufacturers' Association.

II. A REVIEW OF THE OZONE LAYER PROBLEM

8. Ozone, a form of oxygen, is found throughout the atmosphere, but formed and found in particular at high altitudes, with maximum concentrations at about 25 km over the equator and at about 20 km in polar regions during the spring. A layer containing about 90% of all atmospheric ozone is located between 10 and 50 km, and is commonly called the "ozone layer". In the lower atmosphere (troposphere), a smaller amount of ozone is derived through the interaction of sunshine, oxides of nitrogen and organic materials such as automobile exhausts and petrol. It is also transported down from the higher altitudes. It is toxic to plants, animals and man.

9. On the other hand, ozone absorbs from the incoming sunshine particular wavelengths of ultra-violet light, which are also harmful to plants, animals and man. One band of ultra-violet light undergoing such absorption of wavelengths from about 290 to 320 nanometres and called "UV-B" is known to cause skin cancer and aging of skin, decrease productivity in plants, including common food crops, and cause death to early stages of aquatic life. Because of the correlation between sunshine and malignant melanoma, it is believed that this especially dangerous type of skin cancer is also related to sun exposure, though not necessarily to UV-B.

10. In 1974, it was predicted that chlorofluorocarbons (CFCs), such as those used in refrigeration, in foam manufacture and in aerosol spray cans, would be transported to high altitudes and there be photolysed by short wavelengths of sunshine to yield atoms of chlorine(1). The chlorine in turn would act to destroy ozone through a complex chain of chemical reactions. Various other chemicals also threaten a depletion of the ozone layer if they reach the higher atmosphere.

11. Calculations show that a 1% decrease in the ozone would result in an increase in UV-B of between approximately 2 and approximately 3.5% (the "physical amplification factor", sometimes called the "radiation amplification factor"). This increase in UV-B would accelerate the inducing of skin cancer. Studies based on experimental and epidemiological data show that a 1% increase in UV-B exposure would ultimately lead to (at least) a 2% increase in the incidence of skin cancer. This second amplification is referred to as the "biological amplification factor".

12. Since current predictions of eventual ozone depletion by CFCs 11 (CCl_3F) and 12 (CCl_2F_2) alone are of the order of 5-10%, with another third as much again due to other halocarbons, the product of these two amplification factors and the percentage depletion significantly increases the predicted impact of UV-B.

13. This startling possibility generated extensive interest and controversy, and led to new and expanded research programmes, to unilateral action by the United States and Sweden to ban most uses of CFCs in spray aerosol cans, and to a later agreement in the European Economic Community (EEC) not to increase production of CFCs 11 and 12 and to reduce CFC use

in aerosols. However, as noted above, despite these actions it is predicted that present emissions of CFCs will lead to significant depletion and its attendant effects, and the controversy concerning the need for and nature of action to protect the ozone layer still persists

III. THE STATUS OF SCIENTIFIC KNOWLEDGE

14. The World Meteorological Organization issued statements on the ozone layer in 1975 and 1978. CCOL published assessments in 1980 and 1981. The most recent "Assessment of (present and future) Ozone Layer Depletion and Its Impacts" was produced by CCOL in October 1981. It is being made available to the *Ad Hoc* Working Group for use in the drafting of the convention. The assessment is both up to date and authoritative, in that it is a consensus of the members present, which included 13 Governments, a number of United Nations agencies and intergovernmental organizations, and the Chemical Manufacturers' Association (CMA). As part of its report to UNEP and the *Ad Hoc* Working Group, CCOL provided the following summary of its assessment.

IV. 1981 CCOL EXECUTIVE SUMMARY

15. The United Nations Environment Programme's Co-ordinating Committee on the Ozone Layer (CCOL) met in Copenhagen, 12-16 October 1981, for its fifth session. The Committee examined the substantial contributions presented to it by various countries and organizations and the research efforts in observations, evaluations and modelling necessary for the study of the stratosphere. On the basis of existing and new information available the Committee concluded the following:

(a) A risk of depletion of the ozone layer due to chlorofluorocarbon releases is still most likely, although natural variations and other compounds which may affect ozone, require increased consideration.

(b) If one considers only chlorofluorocarbons 11 and 12 releases at their present rates, current calculations estimate an eventual ozone reduction of somewhere between 5 and 10 percent, depending on the model chosen compared to about 10 percent estimated in last year's CCOL report. The change from the 1980 figure is due to new data on certain chemical reaction rates. If present releases of other chlorocarbons are continued at present rates, then they could increase the eventual ozone depletion due to CFC 11 and 12 alone by about one third.

(c) Recognizing the simultaneous and complex impacts of human activities on atmospheric ozone, more realistic scenarios have been developed to study the coupled nature of potential ozone changes. The changes in the trace gas concentrations of N_2O, CO_2, NO_x and CFCs may have all affected the past ozone amounts. The estimate of the present total column ozone depletion is less than one percent, which is below the present detection limit. The relatively large natural variability of atmospheric ozone makes detection of long-term trend difficult.

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(d) Consistent with the study using multiple scenarios from historical data, no evidence of changes in total ozone has been observed This recognizes the significant continuing progress made in statistical analysis of the ozone record. Multiple scenario models suggest that the distortion of the vertical ozone profile might become more important than changes in the total amount with respect to possible climatic consequences.

(e) Observational data indicate an ozone increase in the northern hemisphere troposphere over the last 10 years which is qualitatively consistent with the model-predicted impact from past subsonic aircraft operations and other combustions. Observations in the uppper stratosphere are still inadequate to validate the model-predicted changes due to CFC 11 and 12 releases in the past decades.

(f) Continued improvement of the data base for atmospheric trace species has contributed to the resolution of some past problems in interpretation and pointed out new areas of possible concern.

(g) World production of CFCs 11 and 12 combined as estimated by the Chemical Manufacturers' Association, has fallen by a total of 13% between 1974 and 1980. Most of the decrease occurred in the years 1974 to 1977; only 1% decrease took place in the past year (1980). Uses in aerosols have declined but other uses, for example in foamed plastics and air conditioners have shown an increase. It is recognized that eventually reduction of CFC used in aerosols could be offset by growth in non-aerosol uses. There are also indications of increased production of other chlorine-containing compounds which could affect the ozone layer.

(h) If atmospheric ozone decreases, more solar ultraviolet radiation, in the UV-B range, will penetrate to the earth's surface. New studies have confirmed previous estimates of the relation between ozone decrease and UV-B increase. The health and biological effects to be expected from such an increase of ultraviolet radiation formed one of the main topics of discussion at the meeting. Most of the known effects of UV-B are damaging effects, so that there is concern for the consequences, especially with regard to agricultural production, fisheries and human health.

(i) Recent research results indicate that many terrestrial plants and aquatic organisms may undergo damage by increased UV-B; this applies to important crops such as wheat and rice, and to aquatic organisms such as fish eggs and larvae. Further investigations are needed, however, to assess the overall effects under the complicated actual growth conditions

(j) With regard to human health, it is well-established that an increase in solar UV-B would lead to an increased incidence of non-melanoma skin cancer, especially in light-skinned people.

There are several indications that sunlight may be one of the causative factors of malignant melanoma, which affects people of all skin types. It is presently not known if UV-B is involved; should it be involved, a decrease of atmospheric ozone might be expected to increase the incidence of melanoma.

(k) The Committee emphasized the importance of member countries and international organizations as the World Meteorological Organization (WMO), with the support of UNEP, to provide pertinent chemical production, release and usage data and to continue to collaborate in studies on the ozone layer.

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V. INEVITABLE FUTURE EFFECTS OF TODAY'S ACTIONS

16. Although scientists cannot quantify with confidence the extent of ozone layer depletion due to man's activities (as is evidenced by the various changes in their assessments), they do seem to agree that some amount of change will occur. They also agree that it will occur after an interval, that is, that the chemicals released today will have their effect on the ozone in the future. In this way, man makes inevitable unknown subsequent effects on himself and the biosphere. Analogous situations exist with the release of carbon dioxide through fossil fuel combustion, and the manufacture and release to the environment of a variety of long-lived chemicals and wastes.

17. The Environment Committee of the Organization for Economic Co-operation and Development (OECD) distributed some 15 hypothetical emission scenarios to its members and encouraged those members with ozone depletion models to predict the resultant depletion over time. The purpose was not to describe future emissions as they might occur, constrained or otherwise by regulatory actions, but to examine an array of emission scenarios within an envelope containing any conceivable emission pattern. The resultant calculations of depletion are useful for visualizing: future effects made inevitable by releases in the present; the effectiveness of immediate versus delayed action; and the effectiveness of gradual versus abrupt action to control releases.

18. Six scenarios selected from the United States submission to OECD(3) are reproduced in figures 1 and 2. They are not reproduced here in support of a specific control action but rather to illustrate the magnitude of the issue, as outlined above. The amplitudes and time of occurrence of the scenario peaks will vary between models, and with the chemical rate constants, atmospheric diffusivities and chemical compound lifetimes used in the models.

19. For scenarios III and VI in figures 1 and 2, it can be seen that if emissions are reduced steadily beginning in the year 2000, the greatest eventual depletion occurs some 20 to 30 years later and is about 1.7 times the depletion that exists in the year 2000. From then on the depletion and associated effects begin to lessen, but continue for many decades.

20. It is probable that, despite the many uncertainties still remaining in the models and model inputs, the principles of inevitable future ozone depletion illustrated by these figures will not change significantly. For this reason, the decision when to act cannot be postponed merely because inadequate information exists to act with assurance now. In fact, of course, decisions on whether to act now or later are being made continuously.

VI. THE INABILITY TO QUANTIFY THE EFFECTS

21. The magnitude of the predicted eventual depletion has varied broadly between 5% and 20% since about 1975, with wide confidence limits due to uncertainties in emission rates, in reaction rate constants and in the models (2)(3). There are now more models and groups making predictions, and no uncontested basis for choosing between predictions, so that CCOL elected to report a prediction of ozone depletion of between 5% and 10% instead of a single value with confidence limits (see section IV, para. 15(b) above).

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22. Scientists hypothesize that climatic changes will occur if the ozone concentration changes, as a result of changes in the radiative balance between atmospheric layers and resultant temperature changes. Ozone is only one of the radiatively important gases; water vapour and carbon dioxide also significantly affect the climate, and others could if their concentrations were to increase. Present models can predict the associated temperature changes ("greenhouse effects") due to changes in these trace gases, although not to everyone's satisfaction. They cannot, however, predict specifics of the parameters (such as precipitation) needed for agricultural and socio-economic impact assessment.

23. The magnitudes of the physical and biological amplification factors seem to be accepted for human non-melanoma skin cancer. But, as the CCOL summary states, the magnitudes of the effects on malignant melanoma, on aquatic ecosystems and fisheries, on agricultural production and on climate are quite uncertain. Yet these may turn out to be more serious to the world than the common and curable, if disfiguring, non-melanoma skin cancers.

24. It is most improbable that prediction of specific effects will be available in the foreseeable future (except for non-melanomas). Decision-makers will have to deal instead with subjective estimates of risk, and the scientific community is unlikely to agree on these estimates at least in the next few decades. Decisions will have to be made in the light of the effects of prohibiting the use of ozone-depleting substances for certain purposes after priorities have been established between the different purposes.

VII. PROVING THE OZONE DEPLETION THEORY THROUGH DETECTION

25. Because protection of the ozone layer entails economic and associated social costs, there are those who argue against taking regulatory action until scientists are more certain and "the theory is proven". They caution that man should wait until there is evidence of the depletion of the ozone layer. The only possible direct proof would seem to be actual measurement of a change large enough to be confidently attributed to the chemicals rather than to other causes.

26. There is considerable natural variability in the total amount of ozone above a measuring instrument on the earth's surface. Seasonal variation (March-October difference) at 40 degrees north latitude is about 13% [based on a figure in London and Bojkov (4)]. Daily values at Tallahassee, Florida for a 630-day period in 1973-1975 varied as much as 10% between successive days and by 20% from the mean for the period (2).

27. Statistical treatment of the data from the network of ground-based stations, ozone-sondes and satellite measurements does not show an over-all change of more than 2% in total ozone between 1958 and 1980, according to the CCOL report. The report states that a trend of 2% attributable to combined anthropogenic sources since 1970 is the smallest that could be detected, though the threshold may be as high as 4%. As the record lengthens, one expects to be able to detect a smaller change over the period of the record. However, even if it were possible to measure a 2% stratospheric ozone depletion, should it take place, it remains impossible to attribute this trend confidently to a specific cause, whether CFCs or not, or to man's activities rather than natural causes. In any case, the statistical treatments do not show a 2% change, nor do the models predict that even a 1% change has occurred as yet. These are the same models that predict the 5-10% eventual depletion.

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28. The models also predict an uneven change in the vertical distribution of the total ozone, with greatest depletion occurring around 40 km, a smaller, partially offsetting, increase occurring around 18 km and an even smaller decrease in the lower atmosphere. The data available for detection of changes in vertical distribution appear to be confused by particles from a volcanic eruption, and show disagreement between types of measurements. The global total ozone amount has not changed much, despite a significant and steady increase of up to 20% in ozone in the lower atmosphere (troposphere) reported by a number of stations since 1967. This latter increase is believed to be due to ozone creation through chemical reactions involving oxides of nitrogen from subsonic aircraft and other sources of combustion.

29. Other contributions to variation in ozone and measured ozone over, say, a 10-year period include solar activity and atmospheric dust, for example, from volcanic activity. Other contributions to change in total ozone include the cooling effect in the upper atmosphere due to increased carbon dioxide in the atmosphere (increase), N_2O from fertilizers and changes in land use (decrease), and planned supersonic fleets of aircraft at high altitudes (decrease).

VIII. GLOBAL INVOLVEMENT IN THE PROBLEM

30. It can be seen from table 1 that sales of CFCs 11 and 12 no longer occur predominantly in the United States and EEC. Other countries have increased consumption by 36% from 1976 to 1979, offsetting much of the decrease in the use in aerosols by the United States and EEC.

31. The countries which are believed to produce and distribute CFCs currently include Argentina, Australia, Belgium, Brazil, Canada*, China*, Czechoslovakia, Federal Republic of Germany*, France*, German Democratic Republic, Greece, India, Israel, Italy, Japan*, Mexico, Netherlands*, Poland, Romania, South Africa, Spain, Sweden, Switzerland, United Kingdom*, United States*, USSR and Venezuela. Countries that may produce include Bulgaria, Hungary and Yugoslavia. (Net exporters are marked with an asterisk.)

32. These lists and the notations as to net exporter status are probably neither complete nor current, as only second-hand and limited information is available from Eastern Europe and Asia and the developing world in general. The lists were compiled from unpublished OECD documents, CMA reports, and an early publication by CEQ (5).

33. It is clear that action to protect the ozone layer must not be limited to the United States and the EEC countries. Though the present rate of undergoing economic development in other producers is slow, the sheer magnitude of their populations ensures that they will be capable of overwhelming any reduction in the use of ozone-depleting chemicals in the United States and EEC. Should scientists and decision-makers ever agree upon a global quota for production and release, the mammoth task will remain of dividing up production, use and release between countries.

IX. TRENDS IN USE OF OZONE-DEPLETING CHEMICALS AND SUBSTITUTES

34. Comparing 1980 data with data for 1974, the year when the public began to react to predictions of ozone depletion due to the use of CFCs as aerosol propellants, production of CFCs 11 and 12 combined has

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fallen by 18%. In the past year the reduction has been only about 1%. A further reduction in aerosol use in EEC and other countries would seem possible in view of the Swedish and United States success in achieving a 95% reduction, though it must be recognized that different countries have different economic and legislative problems in effecting controls.

35. Table 2 shows sales of CFCs 11 and 12 by category of use for the world, EEC, the United States and other countries. These data are reflected in figure 3.

36. Not only are other uses of CFCs 11 and 12 increasing and demonstrating a potential to offset the reductions in aerosol use, there is also a slow increase in production of other potentially ozone-depleting chemicals, such as CFCs 22 ($CHClF_2$), 113 ($C_2Cl_3F_3$) and 114 ($C_2Cl_2F_4$); methyl chloroform ($CHCl_3$) and carbon tetrachloride (CCl_4). These other chemicals do not have the same ozone depletion potential per unit of weight as CFCs 11 and 12, and those containing hydrogen (CFC 22 and methyl-chloroform) degrade more rapidly in the troposphere, with a smaller fraction of the releases eventually reaching the stratosphere. The sheer volume of release of some of them, however, makes it essential for them to be considered in any over-all strategy to protect the ozone layer. Table 3 shows the relative contribution of each of several halocarbons to eventual steady-state depletion if releases continue at the present release rate (i.e. with a 0% growth rate).

X. ALTERNATIVES AND SUBSTITUTES

37. The biggest constraints in the substitution of other chemicals for CFCs 11 and 12 are higher cost and certain physical properties (such as their toxicity, flammability and vapour pressure) which make them less desirable for specific uses.

38. The main propellant substitution to date has been that of hydrocarbons. With these there is an increased risk of fire or explosion during use and manufacture. Substitute products such as pump sprays and roll-ons require public acceptance. Dimethyl ether is a possible alternative propellant, but it is flammable and has not yet been cleared as to toxic effects.

39. More than half of all emissions from refrigeration systems occur at the time of disposal. Here recovery is possible, although more expensive than manufacture of new refrigerants, and recovery might be difficult to enforce. In the case of automobile air conditioning, most emissions occur during servicing. Recovery would be quite expensive at servicing as well as at disposal. The use of alternative chemicals as refrigerants carries cost and energy penalties, and for some a toxicity risk as well.

40. CFCs are more expensive than other solvents, and so are already used only in more critical tasks. Emissions could be reduced somewhat as a result of more careful and improved design. Alternative solvents pose health hazards.

41. Methylene chloride could be substituted for much of the present use of CFCs in blowing flexible foams; however, it poses health problems, and toxicological studies have not yet been completed. There appears to be no way to reduce emissions from rigid insulating foams, as the CFCs are an integral part of the foam and, indeed, contribute to their insulating properties. Use of other insulation carries a space and/or energy penalty.

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XI. SOCIO-ECONOMIC CONSIDERATIONS

42 The most obvious effects of control of CFCs (and other chemicals) are the following:

(a) Loss of employment and export earnings for countries with a CFC industry;

(b) Shifting employment within a country from one factory, region or technology to another with accompanying social disruption. Here account must be taken of employment in the feed materials production sector as well;

(c) Changing economic aspects for CFC users in countries with differing laws and regulations;

(d) Probable greater cost of the product to users, with accompanying economic losses;

(e) Probability that the substitute will be less suitable, with consequent inefficiency and possible hazard;

(f) Additional cost of monitoring and enforcement.

XII. REGULATORY OPTIONS

43. The NAS report, and a more recent OECD Environment Committee report not yet derestricted, contain comprehensive discussions of options for control of emissions, and regulatory and socio-economic considerations. The following should suffice to illustrate the complexity of the task of defining and selecting options.

44. To protect the ozone layer, emissions must be limited. The practicability of this course depends upon the chemical, its use, and the immediacy of the emission (compare hermetically sealed refrigerants with aerosol spray propellants). Hence, for practical purposes, it would seem easier to limit production, since what is not produced cannot be emitted.

45. Production (or at least production capacity) should be easy to monitor. Further, it may be assumed that limitation of production will encourage conservation, reclamation and recycling, so that expanded usage would still be possible.

46. On the other hand, different uses have different priorities, and the feasibility of a shift to substitutes varies. Fire extinguishing, medical uses and food refrigeration would seem to have higher priority, and hence a greater right of access to limited amounts of CFCs. Yet it is easier to reclaim and recycle the CFCs in refrigeration equipment than in foam insulation sheets. Both refrigeration and insulation have energy use implications.

47. One possible control strategy would be to add to a convention various annexes relating to production control, and then to allow each country to determine how its production would be used. This is rather simplistic, however, in its cavalier treatment of international trade and of demand from nations that produce less than they currently consume, or "should" consume in the future. It also assumes that chemical companies will not take the simple step of by passing the convention by building production plants in countries that are non-signatories.

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48. The National Academy of Sciences report considered seven broad regulatory options for reducing emissions within a country:

(a) Bans on CFCs in specific applications

(b) Standards for allowable emissions from specific applications either in the form of specific restrictions on emissions or in a requirement to use the best available control technology;

(c) Quotas or ceilings on CFC production or purchase for specific uses. Quotas would be implemented by marketable (transferable) permits, i.e. by "rights" to purchase a certain amount, which could be traded among firms;

(d) Taxes on production and/or use of CFCs, to increase cost and thereby reduce demand;

(e) Deposit-refund systems to create user incentives to recycle;

(f) Subsidies to promote the creation of recycling and recovery activities;

(g) Education and labelling to promote public awareness and consumer concern.

49. The report notes that "some of these approaches are only applicable to a small part of the ranges of CFC uses. None of the approaches appears to be clearly superior to others for the whole range".

50. In short, it was easy to reduce use of CFCs in the United States and western Europe because alternative technologies and public support were available, but additional action becomes increasingly difficult. Further unilateral action would seem unlikely because of the competitive disadvantage suffered by a country that reduces CFC usage by adopting more expensive and less suitable substitutes and technologies.

51. In the meantime, it may be assumed that research on alternatives and substitutes continues.

XIII. THE NATURE OF A CONVENTION

52. It can be considered that the term "framework convention" means an agreement by the signatories to a common objective (e.g. protection of the ozone layer, or reduction of impacts); an agreement to co-operate in research, monitoring and the exchange of information; and an expression of intent to effect future agreements (as annexes to the framework convention) for specific actions toward controls and other measures.

53. It can therefore be assumed that a framework convention will be drafted and signed after a rather lengthy period - caused in part by reluctance to to take action which may later prove to have been hasty, in part by the inherent slowness of international negotiations, and in part by concern that future annexes might be proposed with implicit socio-economic effects which are perhaps not evenly distributed or cannot easily be absorbed by potential signatories.

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54. It is clear that the drafters of a convention will have to provide a fairly clear indication of the nature of future annexes. This means that the probable socio-economic effects of a variety of global strategies will need to be projected and appraised during the drafting of the framework itself.

55. For this reason, and also because the framework convention will probably contain articles calling for co-operation in research, monitoring, evaluation and development of control technologies, the drafters of the convention must include persons of strong technical and scientific expertise including modellers and persons with extensive knowledge of the socio-economic impacts of different strategies for reducing CFC production and use.

XIV. CONCLUSIONS

56. The protection of the ozone layer has many aspects, many of which, including the eventual effects, are not at present quantifiable. However, the predictions of depletion are consistent and not likely to go away or change in sign. At the moment there is general concern that some effects may occur even with the present predicted depletion (5-10% plus another third); this concern is reflected in current efforts to investigate and assess the issues. Moreover, the effects will occur in all countries, not only those producing or using halocarbons.

57. A prediction of still greater depletion as a result of increased halocarbon emissions would increase both the likelihood that effects would occur and concern about such effects. It is reasonable to conclude that, unless present predictions are again revised downward, there is little room left for world production of ozone-depleting chemicals to expand to accommodate world development. A downward revision could occur as a result of new chemical rate coefficients, successful substitution for CFCs 11 and 12 and/or national and international controls.

58. Accepting the validity of the issues presented earlier, and in particular noting the global nature of the problem, it is desirable that as many States as possible should become parties to the convention, not only those which are at present the principal manufacturers and users of CFCs 11 and 12.

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Table 1. CFC 11 and 12 sales (thousands of tons)

	1976(a)	1979(a)	1980(b)
EEC Countries	244	220	...
United States	289	165	...
Rest of world	192	262	...
Total	725	647	641

Sources: (a) Unpublished document prepared by the Commission of the European Communities. (b) CMA report to CCOL.

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Table 2. CFC 11 and 12 sales by use (in thousands of tons)

Category	Year	World	EEC countries	United States	Rest of World
Aerosols	1976	432	177	138	117
	1979	255	137	7	111
	1980	244	...	...	...
Refrigeration	1976	152	21	88	44
	1979	191	20	89	82
	1980	188	...	...	...
Foam	1976	110	42	44	24
	1979	152	56	36	60
	1980	162	...	...	...
Other uses	1976	30	4	19	7
	1979	48	7	33	9
	1980	47	...	...	...
Total all uses	1976	725	244	289	192
	1979	647	220	165	262
	1980	641	...	...	...

Sources: As for table 1.

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Table 3. Relative contribution to ozone depletion resulting from the continued injection of 10 halocarbons at present release rates if total steady-state depletion is assumed to be 8.17 per cent

Halocarbon	Current annual release rate (kilotons per year)	Estimated steady-state ozone depletion, per cent
CFC 11	272	2.94
CFC 12	383	3.28
Carbon tetrachloride	82	0.84
CFC 113	91	0.76
Methyl chloroform	476	0.21
CFC 114	18	0.10
Tetrachloroethylene	608	0.02
CFC 22	72	0.01
CFC 115	45	0.01
		8.17

Source: Modified from reference No. 6.

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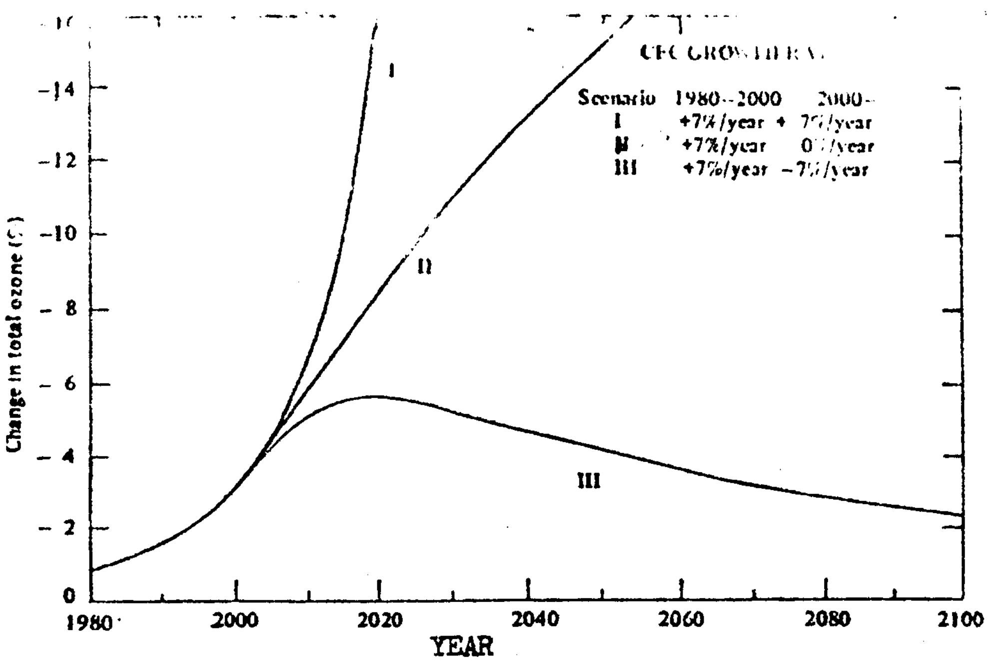
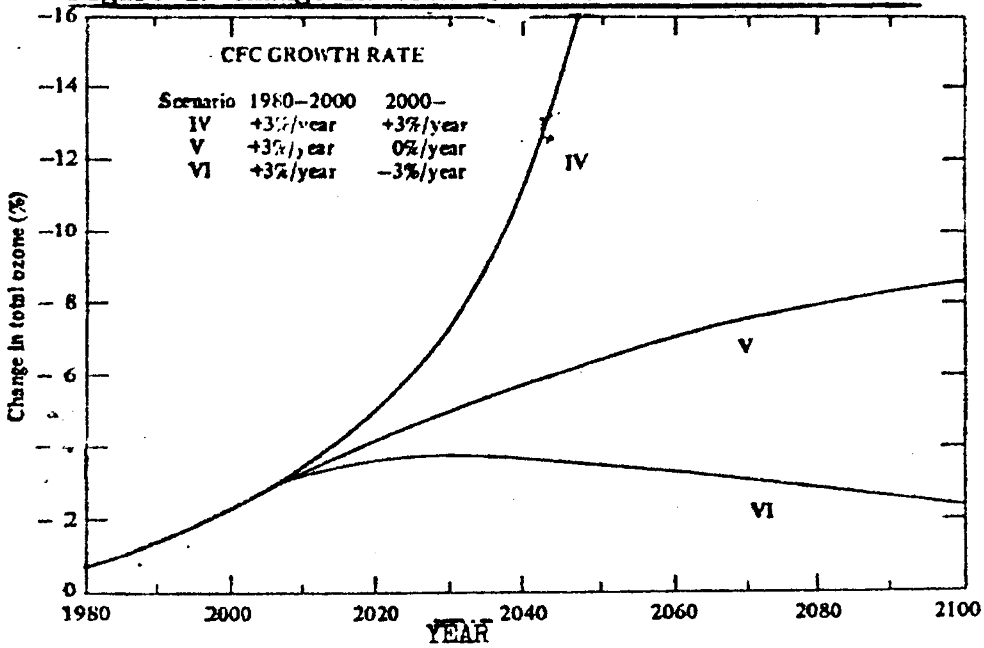
Figure 1. Change in total ozone as a function of time



Source. Reference No. 3

Note. These changes have been estimated assuming 7% growth per year in chlorocarbon emissions (except for CCl_4) until the year 2000, and then, for scenario I, continued annual growth of 7%, for scenario II, no further growth, and for scenario III a 7% annual decrease. Emissions of CCl_4 were assumed to remain at 1980 levels.

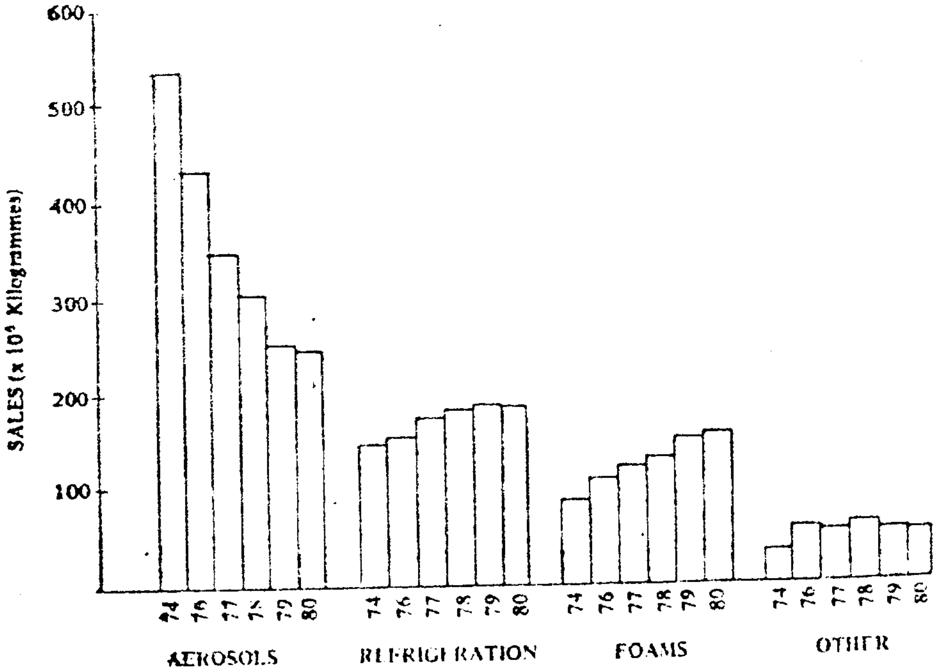
Figure 2. Change in total ozone as a function of time



Source. Reference No. 3

Note. These changes have been estimated assuming 3% growth per year in chlorocarbon emissions (except for CCl_4) until the year 2000, and then, for scenario IV, continued annual growth of 3%, for scenario V, no further growth, and for scenario VI a 3% annual decrease. Emissions of CCl_4 were assumed to remain at 1980 levels.

Figure 3. Total CFC 11 and 1 sales by use category



Source: Table 2.

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