

Comment

Progress Toward a Healthy Sky: An Assessment of the London Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer

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I. INTRODUCTION

Early in the summer of 1990, representatives of ninety-three nations met in London and agreed to amend significantly the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol).¹ The resulting agreement, commonly known as the London Amendments, was the product of several international meetings,² and came amidst rising concern over continued thinning of upper atmospheric ozone as a result of the release of chlorofluorocarbons (CFCs), halons, carbon tetrachloride, methyl chloroform, and other chemical compounds. While imperfect, the agreement represents a heartening step forward in the world community's effort to protect our biosphere from the dangers of increased solar ultraviolet radiation.

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1. Montreal Protocol on Substances that Deplete the Ozone Layer, Sept. 16, 1987, 26 *I.L.M.* 1541 (entered into force on Jan. 1, 1989) (amended the Vienna Convention for the Protection of the Ozone Layer, Mar. 22, 1985, 26 *I.L.M.* 1516) [hereinafter Montreal Protocol]. For the full text of the London Amendments, see *Report of the Second Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer*, U.N. Environment Programme, U.N. Doc. EP/OzL.Pro.2/3 (1990) [hereinafter London Amendments].

2. For journalistic accounts of these meetings, see Whitney, *12 European Nations to Ban Chemicals that Harm Ozone*, *N.Y. Times*, March 3, 1989, at A1, col. 6; Whitney, *London Talks Hear Call for '97 Ban on Anti-Ozone Chemicals*, *N.Y. Times*, March 6, 1989, at B12, col. 1; Whitney, *80 Nations Favor Ban To Help Ozone*, *N.Y. Times*, May 3, 1989, at A13, col. 1; Whitney, *Industrial Countries To Aid Poorer Nations on Ozone*, *N.Y. Times*, May 6, 1989 at A6, col. 1; Shabecoff, *U.S. to Back Fund to Protect Ozone*, *N.Y. Times*, June 16, 1990, at A1, col. 5; Browne, *93 Nations Move to Ban Chemicals that Harm Ozone*, *N.Y. Times*, June 30, 1990, at A1, col. 3; *Parties to Montreal Protocol Agree to Phase Out CFCs By 2000*, *BNA World Climate Change Report*, July 1990, at 3.

This article is a summary and preliminary assessment of the London Amendments to the Montreal Protocol. After describing the original version of the Protocol, the article summarizes the results of pertinent scientific investigations performed both before and after its signing in 1987. It then describes certain critical features of the June 1990 Amendments and assesses the adequacy of these modifications in light of the new research documenting the deterioration of our stratospheric ozone shield.

II. THE MONTREAL PROTOCOL

The original version of the Montreal Protocol was signed on September 16, 1987. The original signatory nations agreed that the Protocol would enter into force on January 1, 1989, provided that it had been ratified by at least eleven signatory states "representing at least two-thirds of the 1986 estimated global consumption of the controlled substances."³ The Protocol consisted of three types of provisions: 1) controls on the production and consumption of ozone-depleting chemicals; 2) arrangements for the administration and enforcement of control requirements; and 3) measures to promote regular, periodic assessments of the Protocol's control provisions.

At the heart of the original Montreal Protocol were its requirements regarding control of compounds that destroy the earth's ozone shield. As an interim measure, the Protocol required a freeze, at 1986 levels, on annual consumption of five fluorocarbon compounds (CFCs-11, 12, 113, 114, and 115), beginning in the seventh month after the Protocol entered into force.⁴ It also called for a similar freeze on consumption of halons-1221, 1301, and 2402, beginning three years from that date.⁵ In addition, the Protocol required scheduled long-term reductions from 1986 levels of CFC consumption of 20% by 1994 and 50% by 1999.⁶

The Montreal Protocol provided certain specific exceptions to its general limitations on CFC and halon consumption to maintain a sufficient supply of CFC and halon-based products⁷ for developing countries, to respond to supply shortages, and to achieve economic efficiency in some of the more industrialized nations. For example, parties to the Protocol that produced less than twenty-five kilotons of ozone-depleting substances in 1986 may, "for the

3. Montreal Protocol, *supra* note 1, art. 16, para. 1.

4. *Id.* at art. 2, para. 1.

5. *Id.* at art. 2, para. 2.

6. *Id.* at art. 2, paras. 3-4.

7. CFCs have a wide variety of commercial uses. They are employed, among other things, as refrigerants, solvents for the cleaning of electronic components, and in the manufacture of flexible and rigid polyurethane foams. Halons are used in fire extinguishers and other products. See Shabecoff, *Industry Acts to Save Ozone*, N.Y. Times, Mar. 21, 1988, at A1, col. 1. See also Browne, *In Protecting the Atmosphere, Choices Are Costly and Complex*, N.Y. Times, Mar. 7, 1989, at C1, col. 3.

Progress Toward a Healthy Sky

purposes of industrial rationalization," trade production rights of those substances in excess of the Protocol's general production levels, so long as the "total combined calculated levels of production of the Parties concerned" does not exceed the production limits that would otherwise apply.⁸ Similarly, the Protocol contained a provision allowing centrally planned economies, such as that of the Soviet Union, to include in 1986 base-year levels the expanded production foreseen in its five-year plans.⁹ The Protocol also allowed regional economic integration organizations, most notably the European Economic Community, to meet their consumption limits jointly, so long as all members of the economic organization had signed and ratified the Protocol.¹⁰

The original agreement provided for the administration and enforcement of these control requirements in that it: mandated procedures for calculating production, consumption, and imports and exports;¹¹ prohibited the importation of ozone-depleting substances from states not parties to the treaty;¹² and banned the export of these substances to nonparty states as of January 1, 1993.¹³ The Montreal Protocol also required participating nations to "discourage" the export of technology for producing and utilizing controlled substances to nonparticipating states,¹⁴ and prohibited treaty participants "from providing new subsidies, aid, credits, guarantees or insurance programmes" for the export of such technology to nonsignatory nations.¹⁵ It further required each party to disclose its annual production, imports, and exports of ozone-depleting compounds.¹⁶ Lastly, the Protocol required each party to promote international cooperation in research, and to exchange information regarding control techniques.¹⁷

The original version of the Montreal Protocol also allowed periodic assessment of the appropriateness of its control requirements. Beginning in 1990, and at least every four years thereafter, "the Parties shall assess the control measures provided for in Article 2 on the basis of available scientific, environmental, technical and economic information."¹⁸ Furthermore, the Protocol required the parties to hold meetings at "regular intervals,"¹⁹ to review imple-

8. Montreal Protocol, *supra* note 1, art. 2, para. 5. *See also id.* at art. 5 (certain developing countries permitted to delay compliance with control requirements for 10 years).

9. *Id.* at art. 2, para. 6.

10. *Id.* at art. 2, para. 8.

11. *Id.* at art. 3.

12. *Id.* at art. 4, para. 1.

13. *Id.* at art. 4, para. 2.

14. *Id.* at art. 4, para. 5.

15. *Id.* at art. 4, para. 6.

16. *Id.* at art. 7, para. 2.

17. *Id.* at art. 9.

18. *Id.* at art. 6. In addition, the Protocol required that at least one year before each such assessment, the parties shall convene "appropriate panels of experts" who shall meet and report their conclusions to the parties. *Id.*

19. *Id.* at art. 11, para. 1.

mentation of the agreement, to assess the control measures, and to consider and adopt any amendments they may deem appropriate.²⁰ The Protocol prescribed that "extraordinary meetings of the Parties shall be held at such other times as may be deemed necessary by a meeting of the Parties, or at the written request of any Party, provided that, within six months of such a request being communicated to them by the secretariat, it is supported by at least one third of the Parties."²¹

III. TRENDS, CAUSES, AND IMPACTS OF OZONE LAYER DEPLETION: THE RECENT SCIENTIFIC INVESTIGATIONS

More than a decade prior to the signing of the original Montreal Protocol, two United States scientists, Mario Molina and Sherwood Rowland, were the first to postulate that released CFCs would be harmful to stratospheric ozone.²² Since that time, much has been learned about the process of ozone depletion. It is now generally accepted that stratospheric ozone is constantly created, destroyed, and recreated in the upper part of the atmosphere (the stratosphere) by numerous photochemical reactions. The release of CFCs, halons, and other gases alters the balance of these natural cycles of creation and destruction. Because CFCs are particularly stable compounds, they do not break up in the lower atmosphere (the troposphere). Instead, they gradually migrate to the stratosphere where, in the presence of ultraviolet radiation, they are broken down, releasing chlorine in the process. This free-floating chlorine remains after the chemical reaction to act as a catalyst in further chemical reactions, destroying more ozone.²³

This destructive process has significant implications for human beings, plants, aquatic organisms, and human-formulated materials. There is evidence that the ozone layer acts as a shield to block out ultraviolet radiation, but when the ozone layer is depleted, the increased ultraviolet radiation levels may induce certain types of skin cancer, cause cataracts, and suppress the human immune system.²⁴ In addition, many varieties of terrestrial and aquatic plants are affected by increases in ultraviolet radiation resulting from ozone depletion.

20. *Id.* at art. 11, para. 4.

21. *Id.* at art. 11, para. 1.

22. See Molina & Rowland, *Stratospheric Sink for Chlorofluoromethanes: Chlorine Atom-Catalyzed Destruction of Ozone*, 249 NATURE 810 (1974).

23. For a more detailed description of the chemical nature of this product, see Titus & Seidel, *Overview of the Effects of Changing the Atmosphere*, in I EFFECTS OF CHANGES IN STRATOSPHERIC OZONE AND GLOBAL CLIMATE 4 (1986) [hereinafter STRATOSPHERIC OZONE].

24. See generally Emmett, *Health Effects of Ultraviolet Radiation*, in STRATOSPHERIC OZONE, *supra* note 23, at 129; Waxler, *Ozone Depletion and Ocular Risks from Ultraviolet Radiation*, in STRATOSPHERIC OZONE, *supra* note 23, at 147.

Progress Toward a Healthy Sky

They include important crops such as peas, beans, squash, melons, and cabbage.²⁵ Furthermore, many species of phytoplankton -- the primary food source for most fish²⁶ -- are also at risk. Increased ultraviolet radiation also contributes to property damage such as fading paint, yellowing of window glazing, and chalking of polymer automobile roofs.²⁷

Recent research into the nature and effects of ozone depletion -- research that postdates the signing of the original Protocol -- has yielded other troubling conclusions. In August and September 1987, the United States National Aeronautics and Space Administration (NASA), in cooperation with a number of other organizations and government agencies,²⁸ studied the yearly springtime decrease in antarctic ozone which scientists have observed since the late 1970s. This study, based in Punta Arenas, Chile, consisted of twenty-five research aircraft flights over Antarctica at high and medium altitudes. It found clear evidence of a link between stratospheric ozone depletion and the presence of chlorine and bromine in the stratosphere. It also concluded that the antarctic ozone hole was expanding as a result of both chemical and meteorological mechanisms, the precise nature of which is still unknown.²⁹

Not long after the Punta Arenas study was released, a group of more than one hundred of the world's most distinguished atmospheric scientists issued the *Executive Summary of the Ozone Trends Panel Report (Panel Report)*.³⁰ This summary incorporated data from a comprehensive, eighteen-month review of ground-based and satellite data concerning ozone layer depletion, as well as the results of the Punta Arenas study and other scientific expeditions to the Antarctic. The *Panel Report* concluded that "there has been a large, sudden, and unexpected decrease in the abundance of spring-time antarctic ozone over the last decade"³¹ and "[t]he weight of the evidence strongly indicates that man-made chlorine species are primarily responsible for the observed decrease in ozone within the polar vortex."³²

The *Panel Report* also found that "[t]here is undisputed observational evidence that the atmospheric concentrations of a number of the gases that are

25. See generally Teremura, *Overview of Our Current State of Knowledge of UV Effects on Plants*, in STRATOSPHERIC OZONE, *supra* note 23, at 165.

26. See generally Worrest, *The Effect of Solar UV-B Radiation on Aquatic Systems: An Overview*, in STRATOSPHERIC OZONE, *supra* note 23, at 175.

27. See Titus & Seidel, *Overview of the Effects of Changing the Atmosphere*, in STRATOSPHERIC OZONE, *supra* note 23, at 7.

28. See generally NAT'L AERONAUTICS & SPACE ADMIN., ANTARCTIC OZONE: INITIAL FINDINGS FROM PUNTA ARENAS, CHILE (1988). Cooperating entities included the United States National Oceanic and Atmospheric Administration, the United States National Science Foundation, the United States Chemical Manufacturers Association, and the British Meteorological Organization.

29. *Id.* at 8-9.

30. NAT'L AERONAUTICS & SPACE ADMIN., EXECUTIVE SUMMARY OF THE OZONE TRENDS PANEL REPORT (1988).

31. *Id.* § 2.0, para. 12.

32. *Id.* § 2.0, para 17.

important in controlling atmospheric ozone and climate are increasing at a rapid rate on a global scale because of human activities."³³ The analysis of data compiled between 1969 and 1986 by ground-based Dobson instruments³⁴ showed that even after taking into account the effects of natural geophysical variability, "measurable decreases" occurred in the annual average of total column ozone in the Northern Hemisphere. These decreases averaged 1.7% to 3% per year at latitudes between 30° and 64°.³⁵ According to the *Panel Report*, the decreases may be due "to the increased atmospheric abundance of trace gases, primarily chlorofluorocarbons (CFCs)."³⁶

Two United States scientists, John Hoffman and Michael Gibbs, published another significant post-Montreal Protocol study of ozone layer depletion.³⁷ They projected future ozone losses at varying levels of chlorine and bromine emissions. Using this approach, they estimated potential atmospheric changes under various scenarios, including complete implementation of the original version of the Protocol. Hoffman and Gibbs found that the reductions required in the original Protocol would yield a substantial increase in chlorine and bromine levels, even assuming substantial global participation. This increase is due to the above-stated stability of CFCs in the stratosphere. Even if output were to decrease, past emissions would accumulate in the stratosphere amounting in a net increase overall.³⁸ In fact, assuming 100% global participation in the original Protocol, Hoffman and Gibbs predicted that by the year 2075 chlorine abundance would grow by a factor of three from current levels.³⁹ They also expected that atmospheric bromine levels would grow at an even greater rate.⁴⁰

Hoffman and Gibbs concluded that any reductions in the emission of fully-halogenated compounds above and beyond those required by the original Protocol would have the potential to "substantially" reduce future chlorine and bromine concentrations in the stratosphere.⁴¹ The extent of these reductions, however, depends upon the speed and magnitude of additional reductions in

33. *Id.* § 3.0 (gases include CFCs, halons, nitrous oxide, methane, carbon tetrachloride, and methyl chloroform).

34. Dobson instruments measure the ability of the atmosphere to absorb wavelengths of ultraviolet light. *Id.* § 4.0.

35. *Id.* § 2.0, para. 3. The *Panel Report* noted, however, that "Dobson data are not adequate to determine total column ozone changes in the tropics, sub-tropics, or Southern Hemisphere outside Antarctica." *Id.*

36. *Id.* § 2.0, para. 4.

37. HOFFMAN & GIBBS, FUTURE CONCENTRATIONS OF STRATOSPHERIC CHLORINE AND BROMINE, U.S. ENVTL. PROTECTION AGENCY, Ser. No. 400/1-88/005 (Aug. 1988).

38. *Id.* at 1.

39. *Id.* In fact, even if CFC emissions were immediately and totally eliminated, stratospheric chlorine levels would continue to grow for six to eight years as a result of transport delays and long atmospheric residence times. *Id.*

40. *Id.* at 3.

41. *Id.*

Progress Toward a Healthy Sky

emissions. Stabilizing chlorine abundances at current levels would require "a 100% phase out of the fully-halogenated compounds with 100% participation globally, at least a freeze on methyl chloroform use, and substitution of partially-halogenated compounds at relatively conservative rates."⁴² Hoffman and Gibbs predicted that if the date of the full phaseout were to be delayed from 1998 to 2008, the maximum chlorine level would increase by approximately 0.7 ppbv (parts per billion volume), delaying a return to 1985 levels by about seventy years.⁴³

Several months after the publication of the Hoffman and Gibbs' study, the United States National Oceanic and Atmospheric Administration and NASA released the results of the Airborne Arctic Stratospheric Expedition (Arctic Expedition), a project jointly sponsored by both agencies, the U.S. Chemical Manufacturers Association, and the governments of Great Britain and Norway. The Arctic Expedition found that while there is as yet no evidence of an actual loss of stratospheric ozone in the arctic polar stratosphere, its chemical composition is now "highly perturbed." Furthermore, "a considerable portion" of the vortex air in the Arctic is "primed for ozone destruction" as a result of the presence of chlorine and bromine compounds in arctic polar stratospheric clouds.⁴⁴

In addition, data from the World Meteorological Organization's Global Ozone Observing System revealed a decline of nearly 0.5% a year in measured column ozone levels at monitoring stations in Canada and in Central Europe, and a 2% to 3% decline in stratospheric ozone in the equatorial belt over an eleven year period.⁴⁵ Another recent study suggested that a major volcanic eruption could create conditions for an even more dramatic stratospheric ozone depletion by creating large abundances of atmospheric chlorine and sulfuric acid.⁴⁶ Further studies of the antarctic region have concluded that stratospheric ozone depletion was approximately as severe in the winters of 1989

42. *Id.* Stabilization of atmospheric bromine levels requires about a 100% phaseout of halon-1301 and a 90% phaseout of halon-1211, with 100% global participation. *Id.*

43. *Id.* at 26-27. The report also concludes that stabilizing chlorine and bromine levels in the atmosphere would not reverse past depletion. Furthermore, stabilizing chlorine at current levels would not completely prevent the occurrence of future depletion associated with continued dilution from the existing hole. Regrettably, "the global ozone layer may already be committed to a residual amount of depletion at current levels of chlorine and bromine which has not yet had time to occur." *Id.* at 6 (emphasis added). The Environmental Protection Agency recently announced that at latitudes of the United States, ozone loss is much worse than Agency scientists previously predicted it would be. Stevens, *Ozone Loss Over U.S. Is Found to Be Twice as Bad as Predicted*, N.Y. Times, Apr. 5, 1991, at A1, col. 1.

44. For summaries of the findings of The Airborne Arctic Stratospheric Expedition, see Shabecoff, *Arctic Expedition Finds Chemical Threat to Ozone*, N.Y. Times, Feb. 18, 1989, at A1, col. 3 and *Ozone Layer Above Arctic "Perturbed", Not as Bad as Antarctic, Scientists Say*, Env't Rep. (BNA), at 2344 (Mar. 3, 1989).

45. See London Amendments, *supra* note 1, at 7 (statement by Secretary-General of the World Meteorological Association).

46. See Shabecoff, *Large Volcanic Eruption Could Damage Ozone, 2 Researchers Report*, N.Y. Times, May 9, 1989, at C4, col. 1.

and 1990 as in 1987.⁴⁷ While the precise extent of antarctic ozone depletion in 1990 was not determined at this writing, preliminary data from balloon-borne instruments indicated no ozone at all in a layer of atmosphere between 9.3 and 10.8 miles above the Antarctic Continent. This is the first time that a severe hole in the antarctic ozone shield has been found in two successive years.⁴⁸

IV. CRITICAL FEATURES OF THE LONDON AMENDMENTS

Faced with strong evidence that increasing stratospheric ozone depletion poses a serious and growing threat to human health and the world environment, the parties to the Montreal Protocol instituted important modifications in several of the Protocol's central provisions. These modifications include: 1) adjustments strengthening existing measures for the control of substances covered by the original Protocol; 2) control measures for ozone-depleting substances not originally regulated; 3) establishment of a multilateral fund to assist developing countries in meeting Protocol commitments; and 4) provisions for further investigation of specific scientific, technical, and legal matters. In addition, the parties adopted guidelines on the use of "transitional substances" until ozone-depleting chemicals can be phased out.

The London Amendments significantly adjust the CFC control measures called for in the original version of the Montreal Protocol. By 1995, the Amendments require a fifty percent annual reduction in developed nations' consumption and production of CFCs as compared to 1986 levels. These nations must achieve an eighty-five percent reduction by 1997 and a total phaseout by 2000.⁴⁹ The Amendments grant developing nations more time to comply with these limitations. These states may exceed the CFC consumption and production levels to satisfy their "basic domestic needs," while developed nations are limited by up to 10% in 1995 and 1997, and up to 15% in 2000.⁵⁰

Similarly, the London Amendments adjust control measures for halons. By 1992, developed countries must reduce their production and consumption of these compounds to 1986 levels. These countries must not surpass fifty percent of 1986 levels by 1995, and must achieve zero production and consumption by 2000.⁵¹ Once again, developing nations are permitted to exceed otherwise applicable production and consumption requirements by up to 10% in 1992 and

47. See *Ozone Layer Destruction Accelerating, U.K. Environment Secretary Patten Says*, BNA World Climate Change Rep., July 1990 at 4; Browne, *Ozone Hole Reopens Over Antarctica*, N.Y. Times, Oct. 12, 1990, at A8, col. 3.

48. *Id.*

49. London Amendments, *supra* note 1, at 22-23.

50. *Id.*

51. *Id.* at 23-24.

Progress Toward a Healthy Sky

1995, and by up to 15% in the year 2000.⁵² The parties also agreed to identify by January 1, 1993, any "essential uses" of halons for which "no adequate alternatives are available." They may also decide to exempt such uses from the requirement set for 1995 and 2000.⁵³

The London Amendments considerably expand the universe of chemical compounds subject to regulation. For developed nations, they require a twenty percent reduction by 1993 of 1989 levels of production and consumption of ten previously unaddressed fully halogenated CFCs. They further call for an eighty-five percent reduction by 1997 and a total phaseout no later than the year 2000.⁵⁴ Production and consumption levels of carbon tetrachloride must be reduced 85% by 1995 and 100% by the year 2000.⁵⁵ Methyl chloroform consumption and production must be reduced to 1989 levels by 1993. This amounts to a reduction of at least 30% by 1995 and 70% by 2000, with a complete phaseout no later than the year 2005.⁵⁶

Another important feature of the London Amendments is their creation of a multinational fund to provide developing nations with financial and technical cooperation -- including the transfer of technologies -- to enable those nations to comply with the control measures of the Protocol.⁵⁷ The Amendments establish an Executive Committee to administer the new fund, in cooperation with the World Bank and the United Nations Environment Programme.⁵⁸ Developed nations may meet their funding obligations through bilateral or regional assistance, so long as they comply with certain preconditions.⁵⁹

The London Amendments contemplate that parties to the Montreal Protocol will investigate actively a number of scientific, technical, and legal issues regarding control of ozone-depleting compounds. For example, the Scientific Assessment Panel (Assessment Panel) created by the Montreal Protocol was directed to evaluate the "ozone depletion potential, other possible ozone layer impacts, and global warming potential of chemical substitutes" for substances controlled under the Protocol.⁶⁰ The Assessment Panel also was asked to evaluate the likely ozone-depletion potential of other halons that might be

52. *Id.*

53. *Id.*

54. *Id.* at 27-28. Once again, exceptions are included to allow for the satisfaction of "basic domestic needs" of developing countries. These nations may exceed 1993 and 1997 requirements by up to 10% and the zero production and consumption requirement by up to 15%. *Id.*

55. *Id.* at 29. Developing countries are permitted to exceed 1995 allowable levels by up to 10% and the total phaseout requirement by up to 15%. *Id.*

56. *Id.* at 29. This portion of the London Amendments conforms to the pattern established earlier as to developing countries. It allows them to exceed by 10% the otherwise applicable production and consumption levels for the years 1993, 1995, and 2000, and to exceed total phaseout requirements by up to 15%. *Id.*

57. *Id.* at 34-36.

58. *Id.* at 35.

59. *Id.*

60. *Id.* at 16.

produced in significant quantities, as well as engine emissions from high altitude aircraft, heavy rockets, and space shuttles. In addition, the Assessment Panel was asked to analyze the anticipated impact on the ozone layer of the revised control measures called for by the London Amendments.⁶¹

Similarly, the London Amendments directed the Technology Review Panel (Review Panel) to investigate the need for transitional substances in specific applications, along with the "earliest technically feasible dates and the costs" for reduction and total phaseout of methyl chloroform. The Review Panel was also charged with investigating the environmental, safety, and energy implications of chemical substitutes for controlled substances, including the likely availability of substitutes for medical uses.⁶² The Amendments establish *ad hoc* advisory committees of experts to investigate the availability of substitutes for halons,⁶³ the technology to accomplish the prudent destruction of ozone-depleting substances,⁶⁴ and further procedures to address noncompliance.⁶⁵ Furthermore, the Amendments provide that in 1992 the parties to the Protocol must review the situation "with the objective of accelerating the reduction schedule" of CFCs.⁶⁶

The London Amendments contain miscellaneous provisions on a variety of topics. For example, they altered the preamble of the Montreal Protocol to acknowledge the need for a "special provision" to "meet the needs of developing countries."⁶⁷ The definition of "controlled substances" is modified to include isomers of substances specifically identified in the Protocol.⁶⁸ The Amendments also outline a procedure for investigating any party's "reservations" regarding another party's compliance with Protocol obligations, stipulating that all parties ultimately shall decide how to sanction noncompliance.⁶⁹ It was agreed that the Amendments would enter into force on January 1, 1992, provided that at least twenty nations had ratified them by that date. Otherwise, the Amendments would take effect on the ninetieth day following the date of deposit of instruments of ratification by twenty states.⁷⁰

Finally, the parties adopted a guideline to facilitate "the adoption of transitional substances with a low ozone-depleting potential, such as hydrochlorofluorocarbons (HCFCs), where necessary, and their timely substitution by non-ozone-depleting and more environmentally suitable alternative substances

61. *Id.* at 16-17.

62. *Id.* at 16.

63. *Id.* at 11.

64. *Id.* at 15-16.

65. *Id.* at 11.

66. *Id.* at 23.

67. *Id.* at 25.

68. *Id.*

69. *Id.* at 40-41.

70. *Id.* at 39.

Progress Toward a Healthy Sky

or technologies."⁷¹ This guideline provides that use of transitional substances shall be limited to applications where more environmentally suitable alternatives are unavailable and where ozone depletion is minimized.⁷² In addition, the parties agreed to "review regularly" the contribution of transitional substances to ozone depletion and global warming and to replace these substances with more environmentally suitable alternatives "no later than 2040 and, if possible, no later than 2020."⁷³

V. A PRELIMINARY ASSESSMENT OF THE LONDON AMENDMENTS

Although the 1990 London Amendments have notable deficiencies, they nevertheless represent a welcome and significant progress toward the elimination of chemical substances that threaten our planet's stratospheric ozone shield. Phasing out CFCs and halons by the year 2000 in developed countries constitutes a substantial improvement over the grossly inadequate control requirements found in the Montreal Protocol. Similarly, the extension of the Protocol to ten previously unregulated halogenated CFC compounds, as well as to carbon tetrachloride and methyl chloroform, makes progress toward filling regrettable gaps in the original Protocol's regulatory structure.

The newly created multinational fund is another constructive feature of the London Amendments. This fund recognizes the special needs of developing countries and the responsibility of developed nations to overcome economic inequities so as to share with them the technological tools needed to resolve global environmental problems. Although the Amendments provide that the existence of the fund is "without prejudice to any future arrangements that may be developed with respect to other environmental issues,"⁷⁴ the "financial mechanism" contemplated by the Amendments may well serve as a paradigm for international monetary cooperation concerning a host of other environmental issues.

Notwithstanding the encouraging features mentioned above, the London Amendments contain several flaws. For example, the time periods for the elimination of ozone-depleting substances remaining under the agreement are too long. In view of the continuing, well-documented deterioration of stratospheric ozone in several parts of the globe, prompt and total elimination of all such chemicals must be a continuing international priority. In this important respect, the revised Protocol's approach, while a definite improvement over its original version, still fails to reflect fully the urgency of the current situation.

71. *Id.* at 67-68.

72. *Id.*

73. *Id.*

74. *Id.* at 34-36.

The London Amendments' somewhat casual treatment of HCFCs and other "transitional substances" is also problematic. While these compounds are less destructive to the ozone layer than CFCs, they still cause measurable stratospheric harm. Thus, the Amendments' commitment to replace HCFCs with environmentally superior alternatives no later than 2040 and, "if possible," no later than 2020, appears dilatory and incomplete.

Finally, the London Amendments fail to establish a forthright and efficient method for sanctioning parties to the Montreal Protocol who do not comply with its provisions. In view of the continuing need for full global adherence to effective limitations on production and consumption of ozone-depleting substances, the Montreal Protocol would benefit from further amendments authorizing strict trade sanctions on participating nations that fail to meet their pollution control commitments.

Notwithstanding these shortcomings -- some of which ultimately may be eliminated by the continuing framework for study, consultation, and cooperation that the revised agreement provides -- the London Amendments to the Montreal Protocol stand as a laudable international accomplishment. They create a workable institutional mechanism for multinational financial cooperation and technology transfer. Rather than entrenching an outmoded regulatory scheme, the Amendments strengthen and expand vitally needed controls on ozone-depleting substances, and continue a process of international negotiation that may hold the key to further agreements to protect our global environment from human-created perils.