

United States Floats Proposal to Help Prevent Global Ozone Depletion

International negotiations leading to a freeze on emissions of chlorofluorocarbons could force the West to turn to substitutes to maintain living standards and economic productivity

NEXT month international negotiations begin in Geneva on controlling future emissions of chlorofluorocarbons (CFC's). The aim is to prevent the destruction of a band of ozone in the upper atmosphere that shields the earth from harmful ultraviolet radiation. But working out an agreement is certain to be a contentious process because of the changes it portends for industrialized countries where the chemicals are widely used for refrigeration, cooling, aerosol propellants, and in manufacturing.

Demand for CFC's grew dramatically from 1946 through the mid-1970's. The various CFC gases and solvents have played a key role in improving economic productivity since World War II in developed countries, especially in warm climates. The attraction of the compounds has been their low toxicity, small production costs, and efficiency not only in refrigeration and air conditioning systems but also in manufacturing processes. By the early 1970's, however, it was recognized that CFC's posed a potential threat to the ozone layer.

When CFC compounds break down in the ozone layer they release chlorine atoms that strip away one of three oxygen atoms that form ozone when bound together. Most of the world's CFC's are produced and consumed in developed countries in the Northern Hemisphere. The depletion of the ozone belt could be most severe at latitudes above 40° in the Northern and Southern hemispheres, according to Environmental Protection Agency (EPA) projections. Affected would be the northern part of the United States, Canada, most of Europe, the Soviet Union, and parts of China.

Says Richard E. Benedick, the Department of State's deputy assistant secretary for environment, health, and natural resources, "We have got to get a collection of countries to agree that it is wise to take out an insurance policy." He concedes that could "entail some near-term costs," including abandoning certain applications of CFC's, switching to more expensive, or less effective substitutes, and capital investment in new

plant and equipment. Critical to any effort to control CFC use is the participation of European governments. Not only is Europe a major CFC consumer, its chemical producers also export large volumes of CFC compounds.

Just how cautious a posture western European governments, the Eastern bloc, the Japanese, and Third World countries are willing to adopt is unclear. Except for a few Scandinavian countries, much of Europe has yet to ban the use chlorofluorocarbons as aerosol propellants for products such as hair spray. The European Community in the early 1980's did pledge not to expand its greatly underutilized production capacity for certain CFC compounds, and to cut

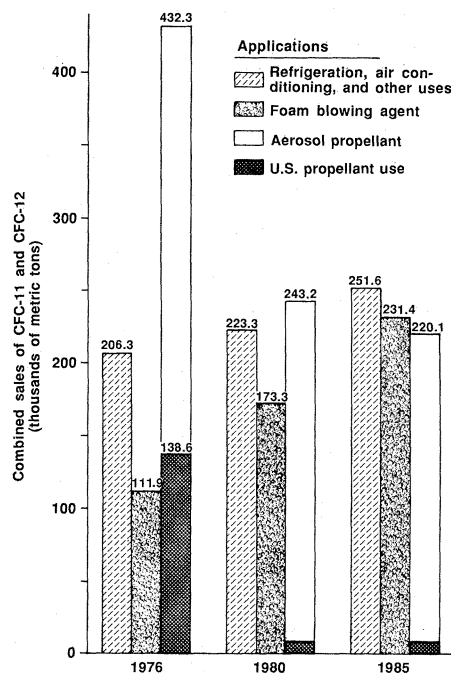
CFC use in aerosols 30%. The actions have been insubstantial compared with the dramatic reductions achieved by the ban on nonessential CFC use in aerosols adopted by the United States and Canada in 1978.

Despite past resistance, "the Europeans are now showing signs of flexibility," says Benedick, noting that the risks of not curbing emissions are increasingly hard for governments to ignore. This is reflected in the fact that 28 nations, including the Soviet Union, have signed the Vienna Convention for the Protection of the Ozone Layer. It was established in March 1985 under the auspices of the United Nations Environment Program. The convention was set up as a mechanism for framing an international strategy for protecting the ozone layer. When representatives of member countries gather in Geneva on 1 to 5 December, they are expected to consider proposals to cap CFC production, if not roll it back.

The actions delegates take in the next few months, though, may be influenced by continuing scientific disagreements over how much CFC loading the atmosphere can handle without significantly depleting ozone levels. No one knows for sure. Because these compounds are extremely stable, having lives of 75 to 100 years, it is hard to tell if the accumulation of CFC's in the ozone layer is close to triggering an appreciable depletion.

The well-publicized hole in the Antarctic ozone layer, which was first detected by the British Antarctic Survey in 1985, has alarmed some scientists because it was not anticipated. Whether the hole results from CFC-related chemical interaction with the ozone layer is a matter of debate. Donald Heath of the Goddard Space Flight Center, who embraces the chemical theory, says it should be clear in a few years whether the deep well in the ozone layer at the South Pole is driven by a solar, wind dynamics, or chemical phenomenon (*Science*, 14 November, p. 817).

But setting aside the issue of the Antarctic hole, satellite data show that for the period 1978 through 1984 the ozone layer eroded



Growing demand. Decline in aerosol use has been offset by increases in other areas. (Estimates are based on data supplied to the Chemical Manufacturers Association by makers of the compounds around the world. Figures for 1985 do not reflect usage by the Soviet Union, Eastern Europe, and the People's Republic of China.)

at an average annual rate of 0.5%. This level of depletion, says Heath, is higher than the 0.1 to 0.2% depletion shown in ground-based measurements. Still, the significance of this is in dispute because volcanic- and weather-related disturbances occurred in the atmosphere during the same period. If the depletion proves to be a trend, however, it might produce devastating effects.

Without measures to control emissions of ozone-depleting agents and future global warming, an EPA report indicates that Americans born before 1985 could develop an additional 1 million melanoma and non-melanoma skin cancers and these will result in 20,000 deaths. For people born between 1985 and 2029 an additional 8.3 million skin cancer cases are expected and 167,000 related deaths. Another 30 million skin cancer cases and 620,000 deaths are projected in the United States for a third population group born between 2030 and 2074.

Animal and plant life also would be adversely affected. EPA analyses indicate that increased numbers of aquatic organisms would die, particularly at the larvae stage. While acknowledging that data are limited, EPA's draft report further notes that crop yield and crop quality could be adversely affected in many instances. Affected, too, would be polymer plastics such as polyvinyl chloride, which would degrade more rapidly with higher ultraviolet radiation. Related costs could run to billions of dollars, the report suggests.

The agency's projections are part of a mammoth 1600-page draft study, "An Assessment of the Risks of Stratospheric Modification," submitted for scrutiny to the agency's Science Advisory Board in early November. It has not been accepted by the agency as yet and is subject to revision.

Kevin Faye, director for the Alliance for Responsible CFC Policy, a coalition of chemical manufacturers and user industries, takes issue with some of the report's findings. The agency's "central case" projecting human health effects assumes that CFC use will grow at an average rate of 2.5% through 2050. Such growth, asserts Faye, "is just not in the cards." EPA notes that a lower growth rate in CFC emissions—1.2%—would slash estimates of new skin cancer cases, related deaths, and cataracts more than 90%.

Industry is equally skeptical about the threats that present CFC emissions are alleged to pose. Richard Barnett, chairman of the industry lobbying group and president of York International, a major manufacturer of heating and cooling equipment, says "We do not believe the scientific information demonstrates any actual risk from current CFC use or emissions."

In September, however, the alliance did acknowledge that it might be prudent to limit future growth in CFC emissions. The action appears to be a recognition that policy-makers in the United States and elsewhere are not going to wait to take action until all the scientific questions are resolved. In October the Du Pont Company went somewhat further by calling on EPA to adopt a negotiation process by which American CFC users, manufacturers, environmentalists, and federal agencies could attempt to work out a unified position.

An agreement to phase out CFC's may be easier to achieve than a treaty limiting uses.

Intensive negotiations between federal officials and interest groups have been conducted in recent weeks. On 5 November the Department of State sent a draft position paper for American embassies around the world to use to sound out foreign governments. The two-step strategy calls for a near-term freeze on production of most CFC's and Halon substances, and a scheduled, long-term phaseout of the chemicals. The strategy aims first to sign up countries that are major producers of chlorofluorocarbons. Adoption of limited trade sanctions to force other countries to abandon CFC's also is advocated.

The position paper also suggests that mechanisms be developed to encourage chemical manufacturers such as the U.S.'s Du Pont, Britain's Imperial Chemical Industries PLC, and Japan's Daikin Kogyo Company Limited, to develop CFC substitutes. A key element of this strategy would be to provide companies with some regulatory certainty that will guarantee markets for higher cost substitutes. The plan also would permit control strategies for certain uses to be altered in the wake of new scientific findings. Exemptions would be provided to CFC users when substitute processes are not available.

American public interest groups—the Natural Resources Defense Council, Environmental Defense Fund, and World Resources Institute—have pushed hard for the Reagan Administration to set its goals high in the first round of negotiations in December. "The U.S. should be going into Geneva asking for sharp cuts and make it plain that there is an international trade implication," says NRDC's David Doniger, who is afraid that the State Department will succumb to a "quick, easy, but ineffective agreement." The

organization says an international phaseout should commence now. This would avoid the economic disruption that might occur later if insufficient action is taken now to protect the ozone later, Doniger notes.

Products that may be scheduled for eventual phaseout include CFC 11, CFC 12, CFC 113, Halon 1211, and Halon 1301. Historically, it has been the use of CFC 11 and CFC 12 in aerosols that have been cited as the major culprits in the depletion of the ozone layer. That is no longer the case. Annual surveys conducted by the Chemical Manufacturers Association show that bans on the use of CFC's for aerosol applications in the United States, Canada, and some Scandinavian countries caused demand for CFC 11 and CFC 12 to fall dramatically after 1976.

While aerosol use has leveled off and is likely to decline further, the application of CFC 11 and CFC 12 in air conditioning, refrigeration, production of foam rubber, and foam insulating board, and packing materials such as plastic egg cartons, for example, has been increasing steadily. As a result total demand for these compounds is near peak levels of the mid-1970's when annual demand hit almost 800,000 metric tons.

In addition, the use of other CFC substances has grown significantly in the last decade. CFC 113, a solvent widely used by the electronics industry for cleaning electronic components and circuit boards, has almost the same ozone depleting potential as CFC 11 and 12. Its use is estimated to have grown from 31,000 metric tons in 1976 to 73,000 metric tons in the United States in 1985. By 2000, Rand Corporation projects the American demand will reach 172,000 metric tons and world consumption will exceed 400,000 metric tons.

Similarly, use of Halon 1211 and Halon 1301 has grown dramatically. These two substances, according to a Rand analysis, have an ozone-depleting potential nine times that of CFC 11 or 12, for example. By the turn of the century world demand is expected to double from 21,600 metric tons in 1985. The two gases are not perceived as posing a significant threat at the moment because they are generally contained in closed systems. Due to their high cost, the chemicals are likely to be recycled when fire control systems are dismantled.

Du Pont officials at this point do not accept arguments by environmentalists that CFC's should be phased out. But in October the company disclosed that given regulatory and market assurances, some substitutes to major ozone-depleting compounds could be made available in 5 years or so. One promising substitute to CFC 12 is CFC 134a, a

substance that deteriorates before reaching the upper atmosphere. Small quantities of 134a were manufactured by Du Pont in 1979 and samples were supplied to a few equipment manufacturers for testing in refrigerators and automobile compressors. The availability of a substitute for automobile air conditioning systems is particularly significant because large amounts of CFC emissions result from these leaky systems.

Paul Halter, business director of Du Pont's Freon division, says that tests show that 134a is a direct substitute in some refrigeration and air conditioning systems. The chemistry of lubricants mixed with CFC's used in compressors must be reformulated, but Halter says this is a minor problem. The chemical also may have applications for foam product producers. Du Pont is not the only company in a position to make this substance, other American, Japanese, and European producers also are capable of manufacturing it, analysts say.

While shifting away from CFC use in aerosols in Europe and elsewhere, or creating replacements for currently used compounds will be relatively easy in some instances, options may be limited in other cases. The electronics industry, for example, relies heavily on CFC 113 to clean circuit boards after components have been soldered. There appear to be few other solvents that can meet the industry's performance standards and that are relatively nontoxic.

Toxicity of substitutes, says Kathleen Wolf of Rand, is often overlooked in the debate about shifting away from CFC's. Though changes may be necessary, she says, the alternatives may carry a higher risk. Companies that now use CFC 11 to produce foam cushions, for example, will turn to methylene chloride, which is more toxic to workers.

Despite these problems and opposition from segments of industry in the United States and abroad, some EPA and State Department officials say a scheduled CFC ban may be the easiest way to reach an international agreement. EPA analyses reveal that a strategy based on just controlling emission levels of traditional CFC compounds could impose steep cutbacks and force Western countries to develop CFC substitutes anyway. To accommodate economic growth, the Eastern bloc and developing nations are expected to demand rights to use additional amounts of CFC beyond current levels.

Under a Canadian proposal that would allocate CFC rights on the basis of gross national product and population, the U.S.'s use of CFC 11 and CFC 12 would have been cut 32% in 1984; actual usage was 238,100 metric tons. Similarly, the Europe-

an Community would have had to reduce consumption 37% to 138,400 metric tons. In contrast, the Eastern bloc would gain rights to nearly double its use of these CFC compounds from an estimated 1984 level of 60,000 metric tons.

This level of disruption, however, may not be enough to get other industrial nations to back the United States plan to phase out CFC's over time. The alternatives—a freeze or rollback—appear increasingly messy. NRDC's Doniger notes that it does not provide industry with any long-term certainty on which to base investments in substitute technologies. Subsequent scientific findings may result in use of CFC's being eliminated anyway. With countries free to consume their CFC allocation any way they

wish, Commerce Department officials note, problems may arise in the trade of products made with or containing CFC's.

Further clouding the issue with respect to American industry is whether the EPA will issue rules that are more stringent than what the international community adopts. The agency is compelled by a federal court order to make a final decision by November 1987 on whether and/or to what extent CFC's should be regulated. Lone action by the United States would not be effective in tackling the perceived global problem. Just what sort of gamble the world is willing to accept on the ozone layer may become clear by April when participants to the Vienna convention are supposed to arrive at a plan. ■ **MARK CRAWFORD**

Changing of the Senate Guard

The return of the Senate to Democratic control, following 6 years of Republican rule, will put some new people—as well as several old hands—in key science policy posts. Although the committee chairmanships will not be decided finally until Senate Democrats caucus in late November, most, if not all, are likely to be allotted strictly according to seniority. Subcommittee chairmanships will not be finalized perhaps until January.

In line to become chairman of the powerful Senate Appropriations Committee is John Stennis (D-MS), who headed the Armed Services Committee in the Senate's previous Democratic incarnation. Stennis,

85, succeeds Mark Hatfield (R-OR).

William Proxmire (D-WI) is expected to get the chairmanship of one of two key appropriations subcommittees that handle the budgets of science agencies. He is in line to chair the subcommittee on labor, health and human services, and education, which oversees the budgets for the National Institutes of Health and other health agencies. But he could instead claim the chairmanship of the subcommittee on housing and urban development and independent agencies, which handles the budgets of the National Aeronautics and Space Administration and the National Science Foundation. If Proxmire decides to stay with the health subcommittee, Patrick Leahy (D-VT) would be the most likely chairman of the housing subcommittee. In line to chair the subcommittee on energy and water development, which oversees the Department of Energy's budget, is Bennett Johnston (D-LA).

The chairmanship of the Committee on Commerce, Science, and Transportation is expected to go to Ernest Hollings (D-SC), who will succeed John Danforth (R-MO). The most senior Democrat currently on the subcommittee on science, technology, and space is Donald Riegle (D-MI).

The new chairman of the Committee on Labor and Human Resources, which oversees NIH, will be Edward Kennedy (D-MA), who chaired the committee before the Republicans took control of the Senate. Kennedy, who was also in line to chair the Judiciary Committee, has decided to head the labor committee because it provides a better forum to challenge the Reagan Administration's domestic priorities. ■

COLIN NORMAN



William Proxmire. *In line to chair appropriations subcommittee that handles NIH budget.*