have been in the $120-billion range. Faced with these estimates at a time when the Pentagon's budget was under severe pressure, Carlucci asked the acquisition board to review the program again. In June, the board recommended that the phase 1 plan be reassessed.

According to Judd, the chief changes to the original plan are these:

■ The garages carrying the space-based rockets would have smaller sensors, while the rockets themselves would be faster and have larger sensors. This would greatly simplify the garages and reduce their cost substantially, and the interceptors would have greater independent capability. There would, however, be fewer interceptors on each garage, and fewer garages. Judd declined to say how many interceptors would be in the system, but other sources say the number has shrunk from 3000 to about 1000 and the number of platforms has been reduced from about 300 to 150.

■ The SSTS would have smaller sensors. To compensate, more of the burden of tracking warheads in space would be placed on sensors lofted into space during an attack by ground-based rockets. One advantage is that the SSTS would require less power, which means that it could be operated with solar cells rather than a small nuclear reactor that has yet to be developed. The BSTS would not change much from the original plan, but it, too, would be powered by solar cells, Judd says.

■ The number of ground-based interceptors would be increased.

■ All the space-based elements of the system could be launched with existing rockets. This means that deployment of phase 1 would not have to wait for the development of a new heavy-lift launcher, and some expense could be deferred. However, says Judd, a new launcher would be required for later phases.

The new proposal is unlikely to win over critics of the earlier plan. Because the basic architecture of the system is not much different, OTA's concerns, for example, will not be diminished. Moreover, one source intimately familiar with the program argues that the decrease in the capability of the SSTS would cause serious problems for the ground-based interceptors because it would not be powerful enough to discriminate between decoys and real warheads. This means, he says, that the ground-based system would be easily overwhelmed. In addition, because only a fraction of the space-based interceptors would be in range of Soviet missiles at any one time, the small number now planned would be incapable of handling launch of more than a few missiles.

■ COLIN NORMAN

EPA: Ozone Treaty Weak

The treaty hammered out by countries participating in the United Nations Environment Program (UNEP) a year ago does not go far enough to protect the stratospheric ozone layer that shields the earth's excessive levels of ultraviolet radiation. Lee Thomas, head of the Environmental Protection Agency (EPA), said 26 September that studies now indicate that chlorofluorocarbons and halons have damaged the ozone layer to a greater extent than previously thought. Thomas said halving the emissions of these compounds as proposed in the treaty no longer appears adequate to protect human, animal, and plant life. He said a complete phaseout of these chemicals is necessary.

The Montreal Protocol, as the treaty is known, was endorsed by 45 nations a year ago and calls for a 50% reduction by 1998 in worldwide production of chlorofluorocarbons (CFCs) and imposes limits on some halons. The treaty is expected to go into effect early next year—as soon as the European Community, Japan, and the Soviet Union ratify the pact. Eight other nations, including the United States, already have given it their final approval.

New analyses released in the past 7 months, however, suggest that production of most CFCs and bromine-based compounds must be virtually eliminated. Otherwise, the stratospheric ozone layer will continue to erode rapidly. UNEP member countries are slated to meet in mid-October in the Netherlands to discuss the treaty and substitutes for CFCs.

When the protocol treaty was drafted, it was expected that a 50% reduction in CFC production might be sufficient to limit the rise in the stratospheric chlorine concentration from a level of 2.7 parts per billion (ppb) to no more than about 5 ppb. The effectiveness of a 50% rollback in CFC production has been in question for some time. EPA, in fact, initially favored phasing out 95% of world CFC production, but backed away from that in response to Administration pressure.

The inadequacy of the protocol strategy first became clear in March when the National Aeronautics and Space Administration (NASA) released the report of the Ozone Trends Panel (*Science*, 25 March, p. 1489). That report's findings showed that ozone depletion was occurring at a faster rate than previously recognized in scientific models. In a study* released 28 September, EPA estimates that under the Montreal Protocol, chlorine levels in the stratosphere could rise to 8 ppb. This is because CFC production levels would remain relatively high. Furthermore, production of methyl chloroform and other halocarbons with relatively low ozone depletion potentials would not be regulated and would rise appreciably.

"It will take a complete phaseout" of CFCs and halons, Thomas said, to stabilize chlorine levels for the next 100 years. Production of methyl chloroform, which is not controlled under the treaty, would have to be frozen, if not curtailed, according to EPA. The chemical is used in manufacturing principally for cleaning metal and electronic components. Once these actions are taken, EPA says chlorine levels in the atmosphere will continue to grow for another 6 to 8 years because the compounds have a long residence time in the atmosphere.

Sherwood Roland of the University of California at Irvine, who along with colleague Mario Molina first warned in 1974 about the threat posed by CFCs, urged Thomas to go further. Carbon tetrachloride, a cleaning solvent, should also be eliminated from the marketplace, Roland contends.

Meanwhile, the Du Pont Company, which first developed CFCs, announced on 29 September that it is building a commercial-scale plant to produce a substitute for CFC-12, a leading ozone-eroding compound used in auto air conditioning, refrigeration, and for other purposes. This compound accounts for 40% of CFCs produced in the United States and about 30% of world production. Imperial Chemical Industries, a British concern, also is gearing up to market substitutes. Du Pont says it will be 5 years before toxicity tests on the substitute compound, CFC-134a, are complete.

■ MARK CRAWFORD

**Future Concentrations of Stratospheric Chlorine and Bromine* [Office of Air and Radiation, Environmental Protection Agency (EPA400/1–88/005), Washington, DC, August 1988].