

data are used for establishing control policies, priorities, and strategies.

To ensure valid, comparable data from the state monitoring networks, EPA has specified reference methods for NAAQS pollutants. Other candidate methods are currently being evaluated for equivalency to the reference methods. For the same purpose, EPA has published guidelines for quality assurance as related to air pollution monitoring. The guidelines cover such aspects as station location, instrument operation, and data handling, validation, and reporting.

Although there are known limitations to much of the ambient data currently being collected, EPA must rely on such data to provide a national overview of the progress in achieving and maintaining clean air. Dependable, reproducible instrumentation, backed by a nationwide quality assurance program are essential prerequisites to the compilation of an accurate composite picture of national air quality and to the equitable administration of control measures.

We have discussed only the major aspects of monitoring ambient concentrations of NAAQS pollutants in the low level atmospheric sector of the biosphere. Analogous programs exist for monitoring water quality, for monitoring emissions of air and water pollutants from their respective

sources, for tracking the fate of toxic substances and radioactive materials, and for assessing the effects of noise. These programs differ widely in their scope and in the specific phenomena being measured, yet all share a common need for accurate, stable instrumentation.

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#### NEWS AND COMMENT

## Nuclear War: Federation Disputes Academy on How Bad Effects Would Be

The National Academy of Sciences, the nation's leading source of scientific advice to the federal government, has issued a confusing and controversial report that it fears might encourage an opportunistic nation to assume it can safely trigger world war III.

The report—entitled *Long-Term Worldwide Effects of Multiple-Nuclear Weapons Detonations*—seemingly concludes that the impact of a nuclear holocaust on nations other than those hit directly by the detonations would not be so catastrophic as many had feared.

That finding was so alarming in its potential for encouraging bomb-happy military planners to let fly that Academy President Philip Handler felt obliged to write a letter of transmittal warning potential war-instigators that factors outside the scope of the Academy study rendered the results of a nuclear holocaust "entirely unpredictable."

But Handler's letter itself became con-

troversial. The Federation of American Scientists, an activist group that counts half of America's living Nobel laureates among its members, issued a public denunciation that came very close to accusing the Academy of inadvertently encouraging war. The Federation charged that the Academy had reached a "false conclusion" (that the effects would be minimal). It also chided the Academy for focusing public attention on a "strange-lovian scenario" (the notion that some nation might consider it advantageous to trigger world war III). Such public emphasis on a scenario that might arouse the "nuclear nuts" or a "monster nation" is "bizarre, unnecessary and possibly counterproductive," the Federation warned.

The U.S. Arms Control and Disarmament Agency, which had contracted for the \$56,000 study, was also dismayed at the tone of the report. It rushed out statements asserting that information in the report actually demonstrates that no aggres-

sor nation could launch a nuclear war without suffering devastating economic and ecological damage from the after-effects of the detonations.

That conclusion is not explicitly set forth anywhere in the Academy's report, its cover letter, or its accompanying press release. But 2 days after the report had been made public, Handler contacted *Science* to express anguish and concern that the Academy had failed to draw what he considered the most important lesson from the study's own data—namely, that the after-effects of a nuclear holocaust would be so devastating that there would be "no hiding place" for anyone. Unfortunately, he said, his letter, and the report itself, give the opposite impression.

Some press reports on the Academy's study emphasized the global damage apt to be caused by nuclear war, but others stressed that mankind would survive.

The report analyzed the likely effects that large-scale nuclear detonations in the Northern Hemisphere of 10,000 megatons (about half the total megatonnage in the arsenals of the superpowers) would have on nations that were not hit directly by the weapons. The focus was on effects that would remain evident as long as 30 years

after the detonations at distances a continent away from the site of the blasts.

The arms control agency was motivated to request the study partly from concern that some catastrophic hazard of nuclear war might thus far have escaped notice and partly in hopes that, if such a hazard exists, it might serve as a deterrent to war.

The Academy's analysis indicates that, while a nuclear holocaust would inflict great destruction, the effects would not be catastrophic on a global scale decades later. This point is particularly emphasized in the interpretations given the report in Handler's letter and in a press release describing the report.

Handler's letter, for example, said that distant humans and ecosystems would be subject to only "minimal stress" a decade or so after a nuclear exchange. He paraphrased the committee's conclusions this way: "If I may restate their principal question as, 'Would the biosphere and the species, *Homo sapiens*, survive?', the response by our committee is, 'yes.'"

The press release, taking its cue from Handler's letter, asserted in its first two paragraphs: "A massive nuclear war, sufficient to bring frightful devastation to the combatant powers, would probably not bring an end to human life . . . the immediate physical and biological consequences would be less prolonged and less severe than many had feared."

Handler recognized the potentially alarming implications of the report. Much of his letter is devoted to placing the "seemingly optimistic" findings "in some perspective, lest they be misinterpreted or misused." He cited the "unimaginable holocaust" that would occur in the nations actually hit by nuclear detonations. He reiterated the report's warnings that regions of high radioactivity could occur far from the detonation sites, and that one cannot exclude the possibility of a major, unfavorable climatic change. He stressed that the report does not address the social, political, or economic consequences of the war—merely the physical and biological effects. Finally, he pointed out that public health resources in surviving nations could be harmed, and that, were the United States and Canada struck, two-thirds of the grain in international commerce would disappear.

All of this means, he suggested, that no distant nation should assume that it "would survive a major nuclear exchange unscathed and, thereby, inherit the earth." Even so, he warned, the United States had

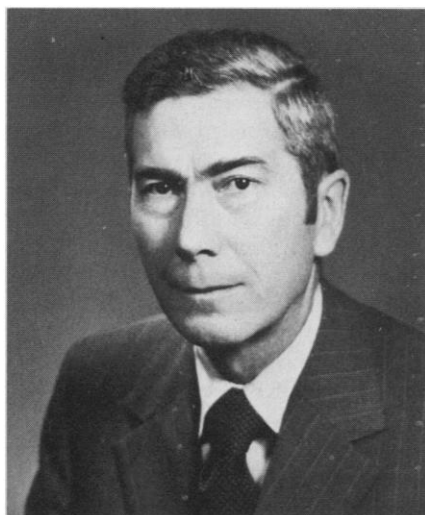


Philip Handler

better be alert to the possibility that some "distant, populous" nation might conclude that a nuclear exchange between other powers is in its own self-interest.

Such caveats did little to allay the Federation's dismay at the basic thrust of the Academy's presentation. In a statement hastily issued to coincide with release of the Academy report, the Federation's executive committee\* charged that the Academy lacked "public policy sense."

The Federation leadership particularly took issue with Handler's "overstated conclusion" that mankind would survive. "Modern science can not assess with much certainty the biological or ecological effects of 10,000 megatons," the Federation said. "A single scientist, tomorrow or next year, may suggest a mechanism—as yet unconsidered—by which the Academy would be flatly wrong in even its extreme formulation of the problem." In contrast to Handler's description of "minimal" long-term consequences, the Federation concluded that "the uncertainties and dangers [cited in the report] could as easily



Fred C. Iklé

have been highlighted as this possibility that the species would survive."

The optimistic interpretation seems strongest in the letter and press release. At least one participant in the Academy study—Farrington Daniels, Jr., professor of medicine at Cornell University medical school—told *Science* he is very concerned about the uncertainties but that this is not reflected in the press release. "The scientists who are involved are scared," he said, "but that doesn't come through, does it?"

But the committee's report itself is no rousing cry of alarm. The 213-page document was prepared by an eight-man committee† assisted by some 48 other scientists who participated in week-long workshops last January. Among numerous findings, the study concluded that

- Nitrogen oxides injected into the stratosphere by large-scale nuclear detonations could reduce the ozone shield that protects us from ultraviolet radiation by 30 to 70 percent, according to preliminary results from one simplified model, with recovery probable in 2 to 4 years.

- Injections of dust and nitrogen oxides into the stratosphere might cause temperature drops ranging from negligible to several degrees, but there is no assurance that a slight warming might not occur instead. Climatic changes would probably fall within the world's normal weather variability, "but the possibility of climatic changes of a more dramatic nature cannot be ruled out."

- Initial effects on natural terrestrial ecosystems "would be detectable and significant but minor in terms of disruption of total system stability. Because of the resiliency of natural ecosystems, recovery during the subsequent 25 years could be expected to be fairly complete."

- The impact on world agriculture would be "significant." It is possible—though we lack the information to know for certain—that ionizing radiation might cause pathogens to mutate into more virulent forms, thus causing disease epidemics in crops and domesticated animals on a global scale. Increased ultraviolet radiation might "scald" or kill such crops as tomatoes, peas, beans, and onions; but corn, soybeans, barley, and alfalfa would be affected only slightly. Normal growth of all plants and animals would be expected to resume when the ultraviolet flux recovered, within 4 to 5 years. A temperature

\*The Federation's statement was prepared by Jeremy J. Stone, the organization's director, and was approved by a majority of the organization's executive committee, including Philip Morrison, chairman; Jerome D. Frank, vice-chairman; Nina Byers; John P. Holdren; Herbert Scoville, Jr.; Herbert F. York; and Stone himself. The eighth committee member, Marvin Goldberger, demurred from the tone of the statement.

†The Academy committee was chaired by Alfred O. C. Neir, of the University of Minnesota School of Physics and Astronomy. Other members were James P. Friend, Drexel University; Louis H. Hempelmann, University of Rochester Medical Center; J. Frank McCormick, University of Tennessee; Dean R. Parker, University of California; Elmar R. Reiter, Colorado State University; Allyn H. Seymour, University of Washington; and Paul E. Waggoner, Connecticut Agricultural Experimental Station. J. Carson Mark, of Los Alamos Scientific Laboratory, served as consultant, while Donald C. Shapero, was the executive secretary.

decrease of 1°C—deemed possible in some scenarios—“would eliminate commercial wheat growing in Canada.”

- Radioactivity would not adversely affect the marine environment, though, “if the upper limits of ozone depletion should be realized, irreversible injury to sensitive aquatic species might occur” from increased solar ultraviolet radiation.

- Ionizing radiation might cause a 2 percent increase in the cancer death rate in the first generation. Solar ultraviolet radiation might cause an increase in the incidence of skin cancer of 30 percent or more in mid-latitudes for a period of 40 years if the ozone is depleted by 70 percent—the upper range of the estimates. At the upper limits, ultraviolet radiation might also give everyone who remained exposed for as little as 10 minutes a severe sunburn with blistering of the skin. Snow blindness and eye injuries would be a major risk in northern regions.

- Significant genetic disease might increase by 0.2 to 2 percent in the first generation.

Most effects were estimated for the Northern Hemisphere, the presumed locale of the detonations. Effects in the Southern Hemisphere would be less by a factor of 2 or 3.

The report makes little effort to analyze the implications of some of its most alarming projections. Thus, it calmly discusses the possibility of a 70 percent decrease in the ozone shield—far worse than the 4 to 5 percent that had been projected for the supersonic transport and had caused such nationwide concern. It also notes that this ozone depletion would allow so much more ultraviolet radiation to reach the earth's surface that anyone venturing outside for as little as 10 minutes would suffer a severe, disabling sunburn. But it fails to point out that this might make it virtually impossible to work in the fields, thereby causing a catastrophic drop in food supplies. How was this overlooked? Because, says Handler, it fell between the chinks of the expert panels. The botanists who considered the effect of the ultraviolet radiation on plants didn't think to worry about farm workers.

The arms control agency, which, like the Federation, is actively seeking reasons that might persuade world leaders to reduce their nuclear arsenals, stressed the damage estimates and uncertainties in the report rather than its optimistic conclusions. Fred C. Iklé, the agency's director, said that “the range of uncertainty of the ozone effect is more threatening than we anticipated, and it leads right into another uncertainty with vast implications: a possible decline in food crops of global proportions.” He also suggested that, if the



Jeremy Stone

Soviet Union launched a nuclear attack, it might suffer an “ecological backlash” that would deprive it “of essential food crops for several years” and otherwise disrupt its economy and ecology.

A. James Hartzler, who served as the arms control agency's liaison man to the Academy, told *Science* that some of the criticism of the Academy report stems from failure to realize that the Academy was looking at very long term, very distant effects, not at the immediate, close-in effects which have been the subject of many previous studies. He said the arms control agency wanted “a search in the corners” to see if there was a potential catastrophe that no one had even dreamed of. “They took a pretty good look around and concluded they don't see one, though long-term climatic change is a possible problem,” he said. That conclusion agrees with Hartzler's own findings in an earlier, less ambitious study. “We have not identified any catastrophic effects,” he said.

Much of the controversy over the report stems from emphasis and interpretation. The Federation and Iklé stress the known dangers and the uncertainties that make it impossible to rule out a devastating effect. Handler's letter cited “minimal” long-term consequences that make it unlikely that mankind will be wiped out.

Why did Handler formulate the issue in terms of survival of the species? As he acknowledged at a press conference, this was his personal formulation, not that of the committee or of the arms control agency. Handler explained that, over the past several years, he has been visited frequently by student activists, and he has repeatedly sought their views on the dangers posed by large nuclear arsenals. He found the students strangely uninterested, apparently because they are paralyzed by the idea that

nuclear war would destroy mankind. Thus, to undercut that notion, Handler said, he emphasized that the species would survive.

Subsequently, Handler told *Science* that he was also “troubled” when he read the report because it seemed to him, on a facile reading, to indicate that “Golly, lots of people are going to survive this thing—nuclear war is not all the hell that people seem to worry about.” So he focused his cover letter on putting that conclusion into perspective. But in the process, he now laments, he failed to make clear that the report does indeed contain information so disturbing that it should serve as an implicit warning against the hazards of nuclear war. In particular, he cited the possible damage to the ozone shield, which would be “global in dimension,” thus assuring that there is “no hiding place from this particular phenomenon.” Consequently, any aggressor nation that launched a massive preemptive attack would be “hoist on its own petard” and have to live with the ecological consequences of its act. That is the most important lesson to be drawn from the study, he said, but unfortunately neither the report nor his letter said that explicitly.

The episode illustrates two major weaknesses in the Academy's system for preparing advisory reports. One is that the committees of experts too often fail to consider the public policy implications of their work. Had the committee directly confronted the question of what its findings might suggest as appropriate public policy toward nuclear arsenals, it would presumably have done a clearer job of defining the hazards of nuclear detonations.

Another major defect is the influential and largely unsupervised role of the Academy president in determining how Academy reports will be portrayed to the press and public. The reports themselves are put together by expert committees and are reviewed by other experts within the Academy structure—all with the aim of producing the soundest, most unassailable document possible. But the Academy president's letters of transmittal are not subject to such careful checks and balances. They are a vehicle through which Handler presents his personal view of the significance of a committee's work—even though that work is often in areas where he has no special competence. Sometimes, as in this case, Handler's personal interpretation can be greatly affected by idiosyncrasies in his previous experiences. One wonders how Handler would have formulated the issue if those students had told him they thought nuclear war would cause no lasting damage. Would he then have stressed the uncertainties and dangers?

—PHILIP M. BOFFEY