conduct exchanges with the Soviets through bilateral agreements rather than multilateral organizations.

IIASA has submitted proposals for smaller grants to other government agencies, but the fate of these is now uncertain. Moreover, some of the foundations that have provided funds for U.S. membership in IIASA have made it clear that their commitment is not open ended.

Also uncertain is the fate of a second proposal for another $500,000, which was submitted to NSF last November for FY 1987. This has been sent outside NSF for peer review, which is expected to be completed in the next few weeks. If it passes muster, it will then be subject to another round of policy review.

IIASA's supporters are looking for some help from Congress. A letter signed by Brooks, Carl Kaysen of MIT, who is vice chairman of the U.S. Committee for IIASA, and Howard Raiffa of Harvard Business School, a member of the IIASA council, has been sent to key members of the House and Senate. It says that if there are no national security grounds on which to disapprove the funding—which the NSC apparently concedes—the decision "appears to be an unwarranted intrusion by the NSC into normal NSF procedures." The letter suggests that a congressional examination of the NSC's action is warranted. IIASA officials are also scheduled to testify this week before the House appropriations subcommittee that handles NSF's budget.

Although the first $500,000 proposal appears to be dead, IIASA supporters are pinning their hopes on the FY 1987 proposal. If it is approved by NSF after external peer review, at least they would be on more solid ground in arguing that IIASA's work is worth supporting from a scientific standpoint. That could be important, for IIASA's most prominent piece of work so far, a major review of global energy strategies, has encountered some pointed criticism of the computer models that led to the study's conclusion that rapid development of all forms of energy—including breeder reactors and synthetic fuels—is required (*Science*, 4 January 1985, p. 34).

However, if the foreign policy review drags on as long as it did for the first proposal, IIASA could be in financial trouble. The letter from Brooks, Kaysen, and Raiffa spells out three possible consequences of the NSC decision: "the institution may unravel; it might limp along with an interim Western European or Japanese director; or it might even thrive without major U.S. participation." It adds: "All these alternatives are undesirable from the U.S. perspective." ■ COLIN NORMAN

Plutonium by the Ton

The fate of the defense production reactors hangs on the need for plutonium, and information on that is hard to find

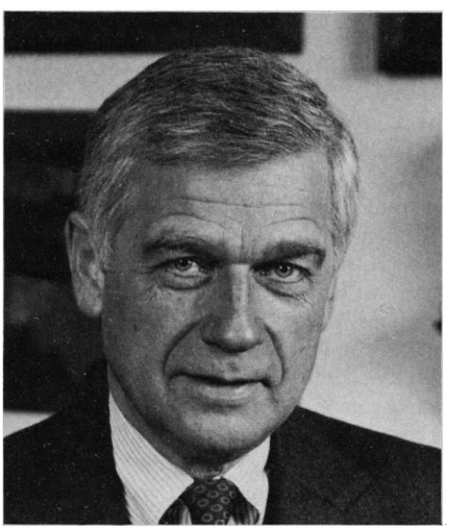
As they were compiling a report on the defense nuclear program a few weeks ago, Senate staffers ran unexpectedly into Executive Branch censors.

"We had a graph without numbers—just a couple of trend lines" showing the military's need for fresh nuclear material, says Stephen L. Crow, senior staffer for the energy appropriations subcommittee. One line showed the production of new warheads in the 1980s. The other showed the rate at which old weapons were being retired. The demand for material for new weapons was roughly in line with the rate at which it is recovered from old weapons.

The graph will not be published. When Department of Energy (DOE) officials saw it, they said it contained secret information.

The graph was similar to others put out by DOE to show 20-year trends in explosive power in the U.S. stockpile, according to Crow. But this one illustrated a different point: that DOE's production reactors "are not the main source of material for weapons." Most of the material comes from old weapons being taken out of service. This applies to plutonium-239, which has a half-life of 24,000 years, not to the other component, tritium, which has a half-life of 12 years and must be steadily replenished.

This is a touchy subject this spring, not only because the Soviets may be interested. DOE's main plutonium production reactor, the N reactor at the Hanford Reservation in Washington, has been shut down since December for safety improvements. In addition, three other usable reactors based at the Savannah River Plant in South Carolina were cut back to one-half power in March, also for safety reasons (*Science*, 27 March, p. 1563). The output of material for nuclear weapons has been sharply reduced.



Senator Mark Hatfield. *Questions forecast for plutonium demand.*

DOE officials are engaged in an intense but unseen campaign to get these reactors running again, and they are urging members of Congress not to yield to constituents' demands that the N reactor be closed for good. On the other hand, members from the Pacific Northwest are asking the department to provide a strong justification for keeping the reactor on line. It was in just such a meeting between senators and DOE officials in March that the plutonium graph appeared and was promptly classified.

Although DOE's judgment is to be honored, some remain skeptical. Senator Mark Hatfield (R–OR), whose constituents live near the N reactor, wonders whether the graph was not offensive as much for its policy as for its technical implications. The question is whether the projected requirements for plutonium reflect real national needs or just a departmental agenda.

DOE officials are loath to discuss the issue in public for fear of violating security rules. However, speaking about the renovation of the N reactor at a press conference last December, DOE under secretary Joseph F. Salgado said, "I will tell you today that national security reasons do not allow the permanent shutdown of the N reactor." He said no more. More recently, Admiral Sylvester R. Foley, Jr., DOE assistant secretary for defense programs, told the *Charlotte Observer* that "a problem of increasing dimensions" has arisen because of the cutback in plutonium output. He reportedly said during a classified hearing in March that supplies could run out in 1991.

While officials were debating these claims and batting numbers back and forth in secret meetings, a private group on 22 April put out an authoritative guide to the whole subject, called the *Nuclear Weapons Databook*, volume II.* It is the second in what is

*Thomas B. Cochran, William M. Arkin, Robert S. Norris, and Milton M. Hoenig, Eds., *Nuclear Weapons Databook*, volume II, *U.S. Nuclear Warhead Production* (Ballinger, Cambridge, MA, 1987).

to be a nine-volume series on every aspect of military nuclear power, published by the Natural Resources Defense Council (NRDC) in Washington, D.C. Its purpose, says editor Thomas B. Cochran, is to make possible an "informed debate." Debates carried on without good information tend to get muddled by emotional appeals.

What are the facts on plutonium production, inventory, and demand? DOE regards this information as classified, but a few authoritative numbers can be found in the databook. It estimates that the amount of weapon-usable plutonium in the stockpile at the end of 1984 was about 93 metric tons (plus or minus 7 tons). The amount produced by the N reactor is about 600 kilograms a year; by the three reactors at Savannah River, about 1500 kilograms a year. The Savannah River reactors also produce tritium and can be adjusted to maximize its output rather than plutonium. These numbers suggest that the total plutonium stockpile is now about 100 metric tons, and that the N reactor adds about 0.5% to the stockpile each year when running.

The demand for plutonium is an arbitrary number reflecting military plans for new weapons over many years. For this reason, it cannot be calculated from physical principles alone and is more easily kept secret. The historic peak in the U.S. nuclear arsenal occurred in 1967, when it held 32,000 warheads. Since then, the number has declined to around 26,000, according to the databook. A lull in manufacturing occurred in the late 1970s under President Carter. In 1980, Carter ordered an increase in warhead production, and between 1982 and 1986 President Reagan added new requirements in several National Weapon Stockpile Memoranda that set goals through the year 2000.

The databook reports that in 1985 there were ten (now seven) warhead types in production at an estimated total rate of 1895 to 2070 per year. The number removed from the stockpile is not given, but the total capacity to manufacture, modify, or disassemble warheads is said to be 3500 to 4000 units a year. The number of warheads in stock has remained level since 1976.

However, several new objectives may put a strain on supplies in the 1990s. One is the decision made in 1981 to build "enhanced radiation" or "neutron bomb" devices, which require more tritium. Another is the emphasis on deployment of small, high-yield warheads, which require more plutonium. Finally, the National Weapon Stockpile Memorandum of November 1982 apparently set a new requirement that 5 metric tons of spare plutonium be kept on hand so that DOE will be able to mount a "surge" in bomb production if necessary.

To cope with the apparent need for fresh plutonium, DOE is considering a number of options, even if the N reactor comes back on line. It may propose building an entirely new production reactor for $4 to $8 billion. The most likely site would be the Savannah River Plant in South Carolina. Alternatively, DOE may want to convert to military use an unfinished commercial plant owned by the Washington Public Power Supply System. DOE also intends to build a Special Isotope Separation plant ($1 billion) to increase the purity of about 11 metric tons of stockpiled low-grade plutonium. This plant could be used for recovering plutonium from spent commercial fuel as well, although a law passed in 1982 bans this option.

The editors of the NRDC databook suggest that there are other ways to satisfy the need for plutonium. William M. Arkin and Robert S. Norris point out that many of the warhead plans announced in the first years of the Reagan Administration have been blocked by political or technical problems. Only one-quarter of the originally planned number of MX missile warheads are to be built, for example. Planned neutron warheads are not to be sent to Europe. Congress has placed limits on the number of nuclear artillery shells to be assembled. The number of advanced Trident II warheads (W88s) has been cut from 4800 to 3000. One way to be sure of having enough plutonium in the 1990s would be to refrain from inventing new "needs" to replace old ones that have been canceled.

Another way to acquire plutonium would be to phase out old systems more rapidly. A particularly rich source of nuclear material may become available if the United States reaches an agreement with the Soviet Union in the current arms negotiations. Success at the bargaining table, of course, should mean that fewer warheads will be deployed.

Slimming the stockpile is not necessarily risky, as Colonel James E. Greening of the Air Force told a House subcommittee last June. Greening, a special assistant to the Secretary of Defense for nuclear stockpile matters, spoke with pride of recent increases in weapon efficiency. Over the last 20 years, the number of weapons in the stockpile has been reduced 25%, he said, "because we have withdrawn many large, high-yield weapons." The total megatonnage has decreased by 75% since 1960. "Significantly, this reduction in numbers and megatonnage was accomplished even in the face of a major increase in the number of Soviet hard targets."

There is every reason to expect that the bomb designers will become more efficient and that this trend will continue. ■

ELIOT MARSHALL

Briefing:

NAS Hopes to Save *Issues*

The National Academy of Sciences has nearly completed plans to resurrect *Issues in Science and Technology*, the science policy quarterly that has been slated to cease publication next month because of concerns about cost and circulation. *Issues*, which received increasingly favorable comment for its editorial content since its founding in 1984, nevertheless did not appeal to a sufficiently large group of subscribers to generate strong subscription income. Its initial circulation of 20,000 has declined to about 10,000 readers. Advertising income was also low and the magazine was losing undisclosed amounts of money.

When attempts to find outside sponsors failed, the Academy, the National Academy of Engineering, and the Institute of Medicine decided last January to terminate *Issues*. Now, however, it looks as though it might be possible to start the journal up all over again. The University of California, spearheaded by UCLA chancellor Charles Young, has agreed to contribute $150,000 a year for 3 years in support of *Issues* and Monsanto has agreed to make a one-time donation of $50,000 to the cause. Those funds, along with support from the NAS, NAE, and IOM, would still leave *Issues* with losses estimated to be in excess of $100,000 a year but the Academy is hopeful that additional resources will be forthcoming. ■

B.J.C.

MIT Gets $3 Million for News Fellowships

The Knight Foundation has just given the Massachusetts Institute of Technology $3 million to support its science journalism program.

In 1983, with start-up funds from the Alfred P. Sloan and Andrew W. Mellon foundations, MIT inaugurated a mid-career fellowship program for journalists and named it after Vannevar Bush, one of MIT's more illustrious graduates.

Under the terms of the new gift, the program will be renamed in honor of Knight Foundation. Thus, the Vannevar Bush Fellowships in the Public Understanding of Science become the Knight Science Journalism Fellowships, and the program is assured a long lease on life. Bush's name, MIT says, will be used in association with certain aspects of the total program, such as a potential series of workshops for news executives. ■ **B.J.C.**