be financed by borrowing on the capital markets rather than from current revenues. Decisions would also be made on a strictly business basis, and industry, which stands to benefit from lower enrichment prices, would bear the risks. The Reagan Administration, which is ideologically committed to getting the federal government out of running businesses, would very much like to turn enrichment over to the private sector, but it is not at all clear how it could be done.

One proposal, under consideration in the White House, is simply to announce that the federal government will not finance any more construction after the first two modules of GCEP. That would at least focus attention on how future capacity should be financed, but it would do little to help avert the budget crunch in the next few years. A more radical idea, put forward by the conservative Heritage Foundation, would be to turn over management of existing plants to a group consisting of utilities that currently have contracts to purchase enriched uranium from DOE. This management corporation would essentially lease the plants for a fee to pay off their depreciated value, and plan and raise capital for future plants. In any case, given the huge uncertainties facing the enrichment business, private industry is not leaping at the investment opportunity.

For DOE, the immediate problem is how to get through the next few years, especially in view of that huge secondary market depressing demand and prices. "Somehow," says Brewer, "we must get through the valley of the shadow—this secondary market problem—and emerge with the best technology." Billions of dollars are riding on how DOE chooses to do it.—**COLIN NORMAN**

Study of Atomic Veterans Fuels Controversy

Criticism of a study of U.S. soldiers in Hiroshima and Nagasaki illustrates the pitfalls of dressing up a political study as purely a scientific investigation

The National Research Council (NRC) recently fired another salvo in an ongoing battle between several veterans organizations and the scientific community over the merits of conducting an epidemiological study of U.S. soldiers who were in Japan shortly after the end of World War II. The veterans, led by a retired mail carrier from Oregon, claim that an unusual number of soldiers who passed through Hiroshima and Nagasaki have developed multiple myeloma, a bone cancer, as a result of exposure to residual radiation after the bomb blasts in 1945.

The NRC, in a controversial report released on 16 July, suggested that the veterans' claims are unwarranted and that an epidemiological study would probably be a waste of time. Specifically, it said that only nine cases of multiple myeloma had been confirmed among members of the occupation force "stationed in or near Hiroshima and Nagasaki." This, said the NRC, constitutes an incidence no greater than that in the general population.

Although the report has been welcomed by the Department of Defense, it has outraged the veterans and attracted pointed criticism from several outside scientists. The National Association of Atomic Veterans, a lobby organized to win financial compensation for veterans who blame their ailments on radiation exposure, has denounced the report as "medically criminal." Glenn Alcalay, an official of the group, says that the NRC ignored some victims of myeloma on a list of U.S. occupation force members compiled by his organization. "If the people who were ignored or are dead from the disease are counted, we're dealing here with an epidemic," he says.

Although there seems to be broad agreement that Alcalay is wrong about a cancer epidemic, several independent scientists agree with him that the NRC report has some serious shortcomings. "The NRC is probably correct in its conclusions, but I think their methodology is slovenly," says Bernard Greenberg, a biostatistician who is dean emeritus at the University of North Carolina School of Public Health. Similarly, Edward Radford, a radiation epidemiologist at the University of Pittsburgh, says "I would doubt very much if there was a significant exposure to radiation by the U.S. occupation force, but I think that the study adds nothing to a discussion of whether there really is more myeloma than one would expect." He and Greenberg agree with the veterans organizations that the NRC failed to look diligently for myeloma victims, and that it may have used an inappropriate control group to estimate whether the occupation force members suffer from excess cancers.

The response of the NRC, which is the operating arm of the National Academy of Sciences, is essentially to acknowledge the presence of shortcomings in the report and to explain that it was intended from the outset to serve a primarily political, not scientific, purpose. "We're not in a purely scientific world here," says Seymour Jablon, a radiation expert who coordinated the study as director of the NRC's Medical Follow-up Agency. "We're in a world of pressures—from the veterans on one side and of course from the government on the other." Jablon is unwilling to describe the report as sound science. "I don't think I want to answer that question," he says.

The idea for the report came from an NRC study in 1981 on the feasibility of conducting a full-scale epidemiological investigation. A panel chaired by Brian MacMahon of the Harvard School of Public Health had been formed at the request of the Pentagon for the purpose of deflecting growing congressional interest in such an investigation, Jablon says. "The Pentagon was searching for a way to resist what they saw as an unwarranted demand for an expensive undertaking. And so they turned to the NRC."

The panel listened to testimony from veterans organizations, the Defense Nuclear Agency, and the National Cancer Institute and concluded that the potential benefit of an epidemiological investigation was not worth the "formidable" cost. The panel reasoned that radiation doses received by the soldiers were simply too low to cause any detectable excess cancers, unless existing assumptions about the effect of radiation on human health are incorrect.*

In what MacMahon describes as a sop to the veterans, the NRC panel did recommend closer scrutiny of a list of alleged myeloma victims compiled by Vic-

*The other panelists were Robert Anderson of the University of New Mexico, John Auxier of Oak Ridge National Laboratory, Stuart Finch of Rutgers University, Alun Jones of Chalk River Nuclear Laboratories in Canada, and Arthur Upton of the New York University Medical Center.

tor Tolley, a retired mail carrier who served as part of the U.S. occupation force and who noticed in 1979 that many of his former colleagues had died of multiple myeloma. Tolley surveyed the membership of the NAAV and developed a list of 500 members of the occupation force, of whom 21 stated that they had myeloma. The NRC supplanted this list with seven additional names supplied by the Defense Nuclear Agency, which had opened a telephone hot line for atomic veterans to call and discuss their medical condition. Neither the agency nor the NRC attempted to systematically cull the names of occupation force veterans from Pentagon files because, they said, it would cost too much and take too long. As a result, the two lists from which the 28 names were drawn included less than 6 percent of those who served in or near Hiroshima and Nagasaki in 1945. "We assumed that the lists included most of the people who thought they had a problem," Jablon says.

The NRC's first act was to ask the Pentagon to ascertain whether the 21 patients on Tolley's list were indeed part of the occupation force stationed in or near Hiroshima and Nagasaki (those who were stationed elsewhere, but who might have passed through the two cities were excluded). The Pentagon, relying on records that it acknowledges to be frequently incomplete, said that nine of those on Tolley's list were not assigned to the relevant occupation units. The NRC then jettisoned these individuals from the study without inviting them to prove the Pentagon wrong. Radford says this was the first of several NRC mistakes. "Those individuals should have had an opportunity to prove they were there by providing corroborating information."

Next, the NRC study directors—Daniel Weiss and Dennis Robinette—sent letters to the remaining 19 veterans. Six veterans failed to respond after receiving three letters, so they too were dropped from the study. No efforts were made to contact people by telephone, Robinette says. Greenberg says this was a serious oversight. "It's almost as if they were trying to throw people away. With a number so small, they should have exploited every avenue possible to reach these people."

Of the remaining 13 veterans, two were later discovered not to have served in or near Hiroshima and Nagasaki, and two did not actually have multiple myeloma. Only five of the remaining nine served in Nagasaki, and this number "is smaller than would be expected based on U.S. population incidence rates and reasonable assumptions concerning the number of occupation troops . . . or their age distribution. . . . It is not possible to form a judgment about the four Hiroshima cases, since there is no way to tell how many servicemen visited Hiroshima City, especially the area about the hypocenter," the report says.

Jablon says that as a result of this study, "there does not appear to be enough evidence to warrant a full-scale epidemiological investigation." But Greenberg questions whether the NRC should draw any conclusions about the nine confirmed cancer cases. He says that an attempt should have been made to estimate how many additional cancer cases were not reported to either the veterans or the Defense Nuclear Agency. This could have been done by determining the overlap on the two lists used by the NRC, and then applying the Sekah-Demig formula, a standard statistical technique, he says. He also says that more effort should have gone into defining the age and size of the occupation force, so that an identical group of veterans—not a similar group of civilians—could be used to estimate the extent of any cancer excess. And he also suggests that the NRC panel neglected to look into the significance of a substantial increase in λ light chain immunoglobulin subunits among the nine confirmed cancer cases.

MacMahon argues, in short, that an excess is so unlikely that a scrupulous search is unnecessary.

MacMahon thinks that some of these criticisms might be appropriate "if the NRC study was a thorough study of multiple myeloma in this population—but it did not claim to be that." The motivation behind the study was primarily political, he says, not scientific. "The whole matter is essentially a political issue." He says that the study "is important primarily because it demonstrates that the veterans' lists include those who were not there [in or near Hiroshima and Nagasaki], and those who didn't have multiple myeloma. This is not to say that there might not actually be an excess of myeloma cases, but a priori, on the basis of what we know, it is unlikely that there would be one." He argues, in short, that an excess is so unlikely that a scrupulous search is unnecessary.

The expectation that a cancer excess is unlikely stems from radiation exposure estimates prepared by Science Applications, Inc., a contractor for the Energy Department and the Defense Department. The firm analyzed extensive radiation readings taken by American and Japanese survey teams in 1945 and concluded that the maximum dosage to any member of the occupation force was no more than 0.1 rad. There is some dispute about this estimate, but even Radford—who says that the doses from the bombs in Hiroshima and Nagasaki have been chronically underestimated—believes that the correct figure is still too low to pose a substantial health risk. Gilbert Beebe, a statistician at the National Cancer Institute who spent 6 years with the Japan Atomic Bomb Casualty Commission (now called the Radiation Effects Research Foundation), notes that even a 1-rad dose is well below the level shown to cause adverse effects in studies involving thousands of Japanese citizens. "There is nothing in the Japanese data below ten rads," he says. "We think there may be effects at lower doses, but it is awfully hard to find them." Beebe, who preceded Jablon as a director of the NRC's Medical Follow-Up Agency, thinks the 8-page NRC report is fine, "in view of the uncertainty about the population and dose." He says that a more detailed study would probably have cost hundreds of thousands of dollars. (The study actually conducted by the NRC cost the Defense Nuclear Agency only $19,000.)

Whatever the likelihood of actually finding an excess of multiple myeloma among occupation force veterans, it seems obvious that the NRC report has done little to dampen the concern of the veterans organizations interested in this issue. They were particularly disturbed that the report—although completed on 23 June—was not released to the public until 16 July, a day that Congress had designated as National Atomic Veteran's Day. Jablon says that this was an unfortunate coincidence caused by the travel schedules of NRC staff.

Several congressmen have already asked the Office of Technology Assessment to look into the overall conduct of the NRC report. A hearing on it may be held later this fall before a subcommittee of the House Veterans' Affairs Committee. As for Victor Tolley, he says he "sees no reason to give up just because the National Academy of Sciences says that there aren't any radiation effects." Tolley, who is 68, says that "it just means that I have to do a lot more work. I'll continue and continue and continue on this until I get some answers."

—R. JEFFREY SMITH