Accelerator Eyed for Warhead Tritium

National laboratory team reports feasibility of tritium production with a linear accelerator; undermines Energy Department plan to spend $6.8 billion on new reactors

IN THE 1990 BUDGET PROPOSAL that just went to Congress, the Reagan Administration reiterated its plan to construct two new production reactors to produce tritium for use in nuclear warheads. The drive to build a heavy-water reactor and an advanced high-temperature gas-cooled reactor, however, could be upset by members of Congress and public interest groups that want to defer funding decisions until alternative tritium production options can be reexamined.

One concept that is intriguing a growing number of legislators is a system based on a linear particle accelerator, or linac. The process could produce tritium more safely than a heavy-water reactor. The basic idea is to accelerate protons and slam them into a lead block that encases a lattice of aluminum-clad lithium rods. Protons interacting with the lead release neutrons that in turn strike the lithium "targets," producing tritium.

Bombarding lithium with neutrons is the same approach used by the Department of Energy (DOE) at its P, K, and L heavy-water production reactors at Savannah River, South Carolina. The principal difference is that at Savannnah River neutrons are generated by atomic fission.

Whether the Accelerator-Tritium Producer (ATP), as the device is being called, ever will be built is not clear. The concept is, however, producing turmoil on Capitol Hill. Representative Sid Morrison (R–WA), ranking Republican on the House Science Subcommittee on Energy Research and Development, wants the incoming secretary of energy, James D. Watkins, to take a fresh look at DOE's tritium production plans.

Environmental groups such as the Natural Resources Defense Council (NRDC) also have joined the fray. "We are prepared to make sure that DOE gives this technology [ATP] full consideration in the environmental impact statement that it is preparing on the new production reactor," says Dan Reicher, an attorney for NRDC.

For General Atomics, which wants to build the high-temperature gas-cooled reactor (HTGR), reopening the technology review on the production reactor is threatening. Likewise, Senator James McClure (R–ID), who fought hard to get DOE to select the Idaho Nuclear Engineering Laboratory as the site for the $3.6-billion gas-cooled reactor, also could wind up a loser. An aide concedes that the ATP concept is interesting enough to cause Congress to delay the HTGR project, if not kill it. McClure's aide blames Representative Morrison for stirring up interest in the linear accelerator idea, saying the he is just trying to land a plant at DOE's Hanford nuclear materials complex, which lies within his district.

More significant support for the ATP may come from the chairman of the House Armed Services Committee, Representative Les Aspin (D–WI). Aspin's committee is reviewing the needs of DOE's entire nuclear weapons production program.

The basic method for producing tritium with accelerators has been understood for 50 years. DOE periodically has funded studies on the feasibility of using accelerators to produce plutonium, to enrich fuel, and to make tritium. Questions about accelerator reliability and the ability to produce sufficient quantities of tritium, however, have caused the government in the past to reject this technology in favor of reactors. Even so, last year DOE again gave a team of scientists and engineers from Los Alamos National Laboratory, Brookhaven National Laboratory, and the Westinghouse Hanford Company $300,000 to reexamine the matter.

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The group briefed DOE's Energy Research Advisory Board (ERAB), which was reviewing production reactor technologies, on its early findings in February 1988. But when ERAB released its report in July, no mention was made of linear accelerator technology. Lawrence T. Papay, the chairman of the ERAB review panel, says it was not clear that the system could be operational within the next 10 years. He told *Science* that his panel members felt they had to choose a proven technology.

DOE's study team, however, has reached a different set of conclusions. While not faulting ERAB for backing a heavy-water reactor, the investigators contend that it may be possible to have an operating ATP plant within the same time frame. The team says it appears that capital costs are competitive with those of a heavy-water reactor.

Rod Powell, the manager for engineering development at Westinghouse Hanford, says the ERAB panel did not have a complete picture of the state of the technology. "We can't find any holes in the physics," says Richard J. Burick, program director for neutral particle beam physics at Los Alamos. But he admits that engineering problems related to building the accelerator are challenging. This would entail building a 1070-meter linac that can accelerate protons to an energy of 1.6 billion electron volts. One of the key technical goals that research teams say they can attain is a current density of 250 milliamperes. "No one has ever built an accelerator with this much energy and current before," observes Burick.

To achieve this energy the team envisions a machine that produces two beams of proton particles, each with current densities of 125 milliamperes. These would be merged to form a single beam. Another hurdle is to learn how to focus this beam so that protons are distributed uniformly over the lead face of the target, the size of which is estimated to be 13 feet by 19 feet. To address some of these problems, the group plans to use some particle beam technologies developed for the Strategic Defense Initiative.

The fate of linear accelerator production plants, however, could rest on society's willingness to pay. The key variable is the operating cost, driven in large part by the plant's power demand—an estimated 775 megawatts. The economics appear to work if the facility is located at Hanford because of cheap hydropower. Almost anywhere else, it would cost more to operate an accelerator than a reactor.

Despite this problem, Burick contends that the findings made by the team since last year justify having DOE's Energy Research Advisory Board convene a panel of accelerator experts to assess the viability of using a linear accelerator to produce tritium.

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