The American Breeder Reactor

COMMENT BY JAY BOUDREAU

From its inception the breeder reactor has been described as a self-fueling energy machine, the answer to our energy needs in the coming century. The United States started up the world's first breeder reactor in 1951 and followed with an operational pilot plant in 1963, the 20-megawatt-electric (MWe) Experimental Breeder Reactor II (EBR II). In 1969 we completed the initial design for an intermediate size (300-MWe) breeder reactor to be built at Clinch River, Tennessee, as the major step toward a commercially viable power generation system. In 1971 President Nixon established the liquid-metal fast breeder reactor (LMFBR) as the nation's highest priority research and development effort. Yet today, ten years later, we have slipped from our world preeminence in breeder technology, and the direction and very future of the breeder development program in the United States is now uncertain.

Meanwhile, the French, the British, and the Russians proceeded with their own original plans: the 250-MWe Phenix, the 250-MWe Prototype Fast Reactor (PFR), and the 350-MWe Bystrye Neitrony (BN-350) all came on--line about 1974. The French and the Russians have continued their programs. The Russian 600-MWe Bystrye Neitrony (BN-600) came on-line in 1979; their 1600-MWe Bystrye Neitrony (BN-1600) is scheduled for 1986. The 1200-MWe French Super-Phenix is scheduled for completion in 1984. Today it is France who leads the world in breeder reactor technology.

The slowdown and all-but demise of the American breeder reactor program have resulted partly from uranium fuel costs, partly from breeder reactor development costs, and partly from the politics of nonproliferation of nuclear weapons. Just the cost of producing plutonium fuel from a breeder is high enough to keep utility companies in the United States from being seriously interested in the breeder at this time. For example, the current market price of mined, processed uranium fuel (yellowcake), which is $25 per pound, would have to increase to nearly $165 per pound in today's dollars before the breeder would be financially competitive with the light-water reactor. cost equivalence might take seventy-five to one hundred years unless crises arise in fossil fuels and imported oil. Consequently, today there is little market pressure to maintain the impetus of the breeder programs begun in the Nixon era.

The cost of development and construction is another problem in the breeder reactor program. Currently, the capital cost of the breeder is significantly higher than that of the light-water reactor. Constructing a 1000-MWe light-water reactor would cost about $1.7 billion, while a fast breeder reactor system of comparable power could cost $3.4 billion. Because of the excessive cost, United States utility companies are reluctant to undertake the purchase of a breeder system without government subsidies. In France, where there is a shortage of domestic energy resources, breeder construction is subsidized as a matter of government policy. However, in this country opposition to such a policy has come from both political parties. For example, in a 1977 letter to the House of Representatives, Michigan Congressman David Stockman, who is now President Reagan's Budget Director, denounced the Clinch River project as "totally incompatible with our free market approach to energy policy."

The politics of nuclear weapons proliferation is still another issue in the breeder program. Because of grave international concern about proliferation, President Carter in April 1977 called for indefinite deferral of construction of commercial breeder reactors. Breeders are considered hazardous because they produce rather large quantities of plutonium, the basic material of nuclear weapons. However, separation of plutonium from breeder reactor fuel requires sophisticated reprocessing, and fabrication of nuclear weapons requires still further technology. The International Fuel Cycle Evaluation report published in 1979 found that the breeder fuel cycle poses no greater threat of international weapons proliferation than does the light-water reactor system. In 1981 an Iraqi reactor was destroyed by Israel in order to stop development of nuclear weapons in Iraq; that reactor was not a breeder but a light-water type. In the United States the proliferation-inspired moratorium has locked up our breeder program for four years; now, under a new administration, we are just beginning to take another look at the program. Whether the breeder development should simply pick up where it left off is open to question.

On the technical side the case for completing the 350-MWe Clinch River breeder reactor as a demonstration, power-producing facility is debatable. The reason for building commercial plants of gradually increasing size is to learn about scaling. It is not possible, for example, to ensure successful construction and operation of a 1000-MWe

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breeder facility by extrapolating from our experience with the 20-MWe Experimental Breeder Reactor II. Thus, Clinch River was to be a steppingstone,

On the other hand, even during the Carter deferral of commercialization, funding for building and testing Clinch River's large components continued. The Department of Energy constructed large facilities specifically designed to test pumps, heat exchangers, and other parts. By now the components have been largely tested, and most of what will be learned from building Clinch River will be how the components behave together in an operating plant. While this is valuable knowledge, its direct applicability is diminished by the fact that present plans for the next generation facility, familiarly known as Son of Clinch, do not retain the same design features. Therefore, from a developmental point of view, the Clinch River project would increase in value if its design were modified to include these new features.

An even more important step toward commercialization would be construction of a larger, more advanced developmental plant. The concept for this larger plant is another result of the moratorium on breeder commercialization. When President Carter stopped the Clinch River project in 1977, he instituted a four-year conceptual design study to evaluate a variety of breeder designs that might minimize the threat of proliferation and enhance overall breeder effectiveness. The report, just issued to Congress last March, outlines a modern, streamlined, large developmental plant with state-of-the-art features not available when the Clinch River breeder was designed. This large developmental plant has more advanced pumps, heat exchangers, steam generators, and cooling loops. Its design is close to what we now envision for commercial plants. However, technical considerations alone do not dictate the timing for such a plant.

There are two questions. How can we finance the large developmental plant? And how should its construction tie in with the now revived Clinch River project? The large developmental plant is in the 1000-MWe range and, as mentioned before, would cost $3.4 billion in 1981 dollars. One option would be to begin the large plant at some time in the future when expenditures for Clinch River have declined, But if too much time elapses, companies will not be able to afford to keep the existing cadre of experienced designers and reactor manufacturers on the payroll. The team will disband, and the price this country will pay is the lead time necessary to reassemble the team. No one really knows how many years this would take or what it would cost.

So far, $1 billion in tax dollars has been spent on Clinch River; the total cost estimate in current dollars is $3.0 to $3.2 billion. The original cost estimate was $700 million. An associated reprocessing facility is also planned, and its development could cost as much as another $1 billion. To build the large plant concurrently would require an innovative financing scheme. One suggestion is a Congressionally chartered corporation composed of personnel from government, from national laboratories, and from industries and utilities. The corporation would be empowered to enter the private capital market to seek funding. The government could provide a loan guarantee and could possibly pay the interest on the loan. The term of the loan would commence during plant construction and would terminate when the loan had been repaid from revenue generated by power sales. Revenue from continued operation would be used to repay Treasury for its contribution of interest monies. Such a scheme could reduce to $800 million the government investment in the large plant.

Two decades ago the breeder reactor was an experimental technology with great promise for solving future energy problems. The United States was a world leader in that technology. Now, when energy is a very immediate problem for most of the world, breeder reactors in France and in the Soviet Union are beginning to fulfill their promise. But we are still in the developmental stage; we have lost our sense of urgency about breeders; and our entire nuclear industry is just beginning to recover from the aftereffects of the Three Mile Island accident.

Our country's energy future is not at all secure; another series of crises over imported oil and new demands and higher prices for uranium could make the breeder reactor very attractive thirty years from now. From our own experience and from watching the European efforts, we know that development and commercial plant production take twenty years or more. We also know that the costs of development and construction are rising rapidly. Much of the preliminary testing of breeder reactor components is done. Now the moratorium is over. It seems a good time to go forward either with a revised intermediate project at Clinch River or with a new large developmental plant—or with both. ■