The Heritage Foundation Backgrounder

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THE CLINCH RIVER FOLLY

INTRODUCTION

When a measure to terminate funding for the Clinch River Breeder Reactor was defeated by just one vote last September, it became clear that support for the program had eroded far more than most people realized. The tenuous support for Clinch River's funding was further underscored by the fact that three Senators known to be unsympathetic to the project were out of town at the time of the vote.

It now appears that there will be another attempt to terminate funding for the Clinch River Breeder during the lame duck session, either as an amendment to an appropriations bill, or as a part of the continuing resolution, should one become necessary. If this move proves successful, it will end a controversy that has lasted nearly a decade--a controversy which is central to the entire future of nuclear energy. It will also end a project that has become a multi-billion dollar folly.

For many conservatives, Clinch River presents a dilemma. They are, on the one hand, strongly supportive of nuclear energy, but they are also concerned about the burgeoning federal deficit. Their opposition to the Clinch River Breeder, therefore, is born more out of a concern to limit federal spending than opposition to nuclear power. The stakes are high. If, as spokesmen for the nuclear industry contend, the death of Clinch River will lead inevitably to the death of nuclear power in the United States, conservatives would undoubtedly continue to support the project. But the validity of this argument has become steadily more doubtful as new uranium discoveries, a general slowdown in the construction of nuclear power plants, and increasingly large cost overruns bring the wisdom of supporting Clinch River into question.

Note: Nothing written here is to be construed as necessarily reflecting the views of The Heritage Foundation or as an attempt to aid or hinder the passage of any bill before Congress.

In order to make a rational decision on continued funding for the Clinch River Breeder, Congress needs answers to a number of questions. Among the most important of these are:

1) What are the prospects for the availability of conventional uranium supplies in the medium term?
2) How does the Clinch River Breeder's technology compare with other options which are competing with it for scarce research dollars?
3) When will a breeder reactor really be needed?
4) How does the development of a breeder reactor fit in with the overall development of nuclear power in the U.S.?

THE GENESIS OF THE BREEDER

When scientists first considered nuclear power for generating electricity, what attracted them most was a reactor's low fuel costs. Initially, the prospective fuel cycle advantages of nuclear powered electricity appeared to be outweighed by the lack of fissile uranium to fuel reactors. Indeed, in 1944, scientists on the Manhattan Project estimated the entire world's supply of fissile uranium could generate the electricity needs of the U.S. for only one and a half years.

This suggested breeding. Only seven-tenths of one percent of the uranium found in nature is fissionable, that is, usable for nuclear power generation. This small percentage is U 235 (which gets its name from having 235 neutrons in its nucleus). Nearly all the rest of the uranium in nature consists of the nonfissile form of the element, U 238. But when this form of uranium absorbs neutrons in a reactor, it undergoes a transmutation into a material not present in nature--plutonium--which is fissionable.

This plutonium transmutation makes breeding possible. If rods of U 238 in a reactor are arranged so just the right amount of neutrons hit them, it it possible to produce more fissile plutonium from the targeted U 238 than is consumed in the reaction. With breeding, it would be possible to extend one and a half year's worth of fuel (circa 1945) into enough to meet the electricity needs of America for 75 to 150 years.

It was because the supply of uranium was thought to be very limited that a breeder reactor seemed to make sense. But Admiral Hyman Rickover's success with light water reactors and the massive new finds of uranium in the Rocky Mountain and Southwest regions of the U.S. during the early 1950s made the breeder far less attractive as a commercial reactor. Moreover, technical problems cast considerable doubt on its commercial viability. Breeders use volatile sodium as a coolant, and so the welds and fittings in these reactors must be of much higher quality than those in light water reactors. In addition, the problem of sodium volatility means that the fueling of breeders must be done entirely by remote control. These and other technical difficulties require more attention to coolant back-up pumping systems and safety systems in general.

The Atomic Energy Commission (AEC) had been successful in launching the light water reactor as a commercial proposition. Many of these were on order; more were likely. Yet this presented a problem. Domestic uranium reserves have proved to be thousands of times greater than estimated by scientists in 1948. However, the growing orders for light water reactors expected during the 1970s threatened a near-term shortage of cheap uranium supplies.

To meet this perceived crisis, the AEC decided to move on from mere breeder research and development to a breeder demonstration. It was at this point that the Clinch River reactor design was promoted. Seen as a 375 megawatt reactor, it was to be the first step in the AEC's demonstration. Once completed, a final scale up--the Large Demonstration Plant--was to follow and be ready in time for private industry to start building its own breeders by the middle or late 1980s.

THE ECONOMICS OF BREEDERS

Although uranium's price rise in the middle 1970s seemed to fortify the case for building Clinch River, this turned out to be a false sign. There were several reasons for this. One was that although utilities assumed the demand for electricity would continue to grow in the 1970s at the same rate as the 1960s, higher electricity prices in the mid 1970s caused the rate of growth to drop sharply. This caused many of the utilities to cancel their orders for reactors.

In the late 1960s and early 1970s, moreover, the nuclear industry assumed supplies of cheap uranium were limited to known reserves. But, when uranium prices began to increase, there was more incentive to prospect and massive, inexpensive super grade ore finds were made in both Canada and Australia. In the U.S., proven and probable reserves doubled.

This uranium surplus, moreover, is projected to increase. Free world uranium inventories stored out of the ground are already nearly six times greater than annual uranium consumption and are expected to keep growing. By 1991 inventories are projected to be nearly eight times that year's uranium demand. As for U.S. uranium inventories, the Department of Energy (DOE) recently projected that it would take at least 15 years before they are drawn down to normal market levels.

These developments have had a profound effect on estimates of the future size of the nuclear power industry. Official projections of nuclear capacity on line by the year 2000 dropped from a high 1500 gigawatts to the current Commerce Department low of 105 gigawatts--nearly a fifteen-fold decrease. Indeed, uranium ore is now so abundant U.S. mines are being closed for the lack of any market.

None of this has been good news for commercial breeder reactors. Even after a decade of demonstration efforts both here and abroad, fast breeder reactors remain much more expensive to build than light water reactors. The French, who are now most advanced in the demonstration of breeder reactors, freely admit that their reactor costs at least 2.28 times that of a comparable conventional light water reactor. While some improvement is expected, they expect to bring the comparative capital cost of a "mature" breeder down to 1.68 times that of a light water reactor.

This capital cost differential would change to the advantage of the breeder only if there were to be significant increases in the price of fresh uranium fuel. Because fuel cycle costs account for just a small percentage of the costs of producing nuclear electricity from a light water reactor--between 10 and 20 percent--uranium prices would have to rise to unprecedented levels before the breeder is likely to become the more attractive option. Even the most favorable analysis suggests that uranium prices would have to increase more than ten-fold, to $188 per pound in 1982 dollars, before a commercial breeder could compete with existing light water reactors. DOE's own study of the issue, published in 1980, projected uranium breakeven prices for liquid metal fast breeders of $180 to $300 per pound (1982 dollars). Finally, in a separate contract study done for the Arms Control and Disarmament Agency in 1981, three uranium breakeven prices were determined: $325 (comparing existing light water reactors with breeders), $403 (comparing improved light water reactors using fuels likely to come on line by 1990 with breeders) and $626 (comparing a light water reactor whose fuel is reprocessed with breeders). The average of these estimates is nearly 18 times uranium's current price.

The General Accounting Office, the Congressional Research Service, and even DOE agree that if a full-sized breeder were now ready to start operation it would be a poor investment at any time in the next 40 years.

THE DEPARTMENT OF ENERGY AND THE CLINCH RIVER PROJECT

Given the high probability that any current or planned liquid metal breeder designs will be uncompetitive, there is serious reason to question whether a near-term breeder demonstrator in the United States makes any sense. This is particularly the case with designs using liquid sodium. The French are so far ahead of the U.S. in their demonstration of the technology that we could learn far more, at much less cost, simply by purchasing French patents and keeping a small team of observers at the French site.

The irony is that the Department of Energy is now diverting funds from its breeder fuels research and development program just to keep Clinch River rolling. This is a major mistake. Breeder research and development is desirable and important to developing advanced fuels for both existing reactors and the next generation. But to link these efforts to the prototype of a single, unattractive, dated breeder design (completed more than a decade ago) is likely to be very harmful to research. DOE instead should focus research and development efforts on a breeder that has: 1) significantly lower capital costs; 2) the ability to be initiated without the cost and delay inherent in plutonium reprocessing; and 3) that is less concerned with maximizing breeder ratios rather than with simply achieving a breeding or conversion ratio of about one.

In December 1981, DOE stated that $1.1 billion had been spent procuring components for Clinch River and that it would take another $2.57 billion to complete the project. Adjusting these figures to 1982 dollars would give a total DOE project cost estimate of approximately $3.6 billion. Even this figure, however, is probably well below the project's likely final cost because the DOE either ignored or grossly underestimated five major cost factors:

(1) The cost of borrowing money from the U.S. Treasury. This is ignored in DOE's Clinch River estimate, yet all private utilities must include the cost of borrowing money in their construction estimates. If Treasury Bill rates are used as a guide to future interest rates (General Accounting Office practice), the interest costs for Clinch River could amount to $4 billion.

(2) Plutonium fuel for Clinch River. Clinch River will require 6 metric tons of plutonium for its first five years of operation. Commercially reprocessed plutonium valued at $40 a gram would cost the project nearly $250 million. If commercial reprocessing is not available, and more refined weapons-grade plutonium fuel must be obtained from DOE's defense programs, the fuel cost would soar to $1 billion. Yet only $10 million was allowed in DOE's original Clinch River cost estimate.

(3) Costs Due to Delay. DOE assumes Clinch River, which is a unique breeder demonstration facility, can be constructed in seven years--less than one-half the time it currently takes to build a standard light water reactor. In addition, DOE has allowed only $200 million as a contingency for cost overruns. Assuming an interest rate of 12 percent, however, a delay of just 1 to 3 years would increase the project's cost by between $400 million and $1.3 billion.

(4) Reprocessing of Breeder Fuel. Clinch River's own fuel must be reprocessed. Yet, DOE's cost estimate makes no provision for such reprocessing. The department is planning to build a $1 billion breeder fuel reprocessing plant, and assuming that 30 percent of the plant is dedicated to Clinch River's needs, this would add $300 million to the bill.

(5) Breeder Fuel Fabrication. DOE's estimate includes money for fabricating breeder fuel for Clinch River. Rather than using this money to buy this service directly from current suppliers, DOE intends to build a new national facility. (the Secure Automation Fabrication Facility). This will cost nearly $500 million, and should be added to the cost of Clinch River.

Including these costs gives a final project cost ranging between $8 to $11 billion. It should be noted, however, that these higher estimates are themselves conservative, in that they exclude all costs associated with Clinch River's waste management requirements, the plant's eventual decontamination and decommissioning, and any further cost escalation.

CLINCH RIVER AND THE PRIVATE SECTOR

In 1971 the Atomic Energy Commission estimated that the Clinch River project would cost $400 million. Private industry was so convinced that breeders would be economical before the 1990s, that it promised to meet over one-half the project's costs--$257 million. But when projected costs jumped to nearly $700 million the following year, the industry stuck to is original $257 million pledge. Since 1972, the cost estimates have escalated ten-to twenty-fold, but the industry has contributed a total of only $122 million, half of which has been in the form of in-kind services. Moreover, in hearings held last year before the House Science and Technology Committee, the utilities' legal counsel argued that because of delay in the project, private industry was no longer obligated to contribute any additional money to Clinch River.

Almost all of the major reactor vendors and nuclear utilities still support the project. One top industry executive privately explained, "The nuclear vendors have supported the project to please their utility customers. The utilities, in turn, support the project because it costs them virtually nothing and because they view it as the ultimate test of government's commitment to nuclear power. If the federal government is willing to fund Clinch River, the utilities figure, it will be willing to fund anything nuclear including the utilities' own errors."

As for providing the Clinch River project with plutonium fuel, private industry is far less interested than it was in the early 1970s. Indeed, it seemed at that time that reprocessing spent fuel from existing light water reactors in order to extract plutonium would be profitable by the early 1980s for use in light water reactors as an alternative to fresh uranium fuel. But the costs of reprocessing have risen far more than the cost of producing fresh uranium fuel--to such a level, in fact, that private industry has been unwilling to finish even the one commercial reprocessing plant in Barnwell, South Carolina, which is over 50 percent complete.

The principal reason for this dearth of industry interest is the lack of any civilian market for plutonium. DOE's total annual plutonium research demand is only a small fraction of the 15 tons of plutonium the Barnwell plant is designed to produce per year. The second factor that has discouraged private industry from engaging in plutonium production is the high storage cost of the fuel. Industry experts estimate that it would cost between $1 to $3 per gram per year to store. Over the lifetime of the Barnwell plant this translates into storage liabilities in excess of $40 billion. So, in the absence of a clear commercial market for plutonium fuel, private industry is loath to assume the risks of proceeding further.

In an effort to keep Barnwell alive, despite the industry's lack of interest, the federal government is willing to guarantee loans of up to $1 billion to corporations willing to finish work on the plant. The government has also promised to buy much, if not all, the plutonium from Barnwell for "future" breeder research. It appears that the government may pay the price of Barnwell's plutonium at the higher level charged for weapons-grade material.

DOE is also trying to bolster industry's flagging interest in the breeder deomonstration program by offering money for work on a follow-on Large Demonstration Plant (LDP) breeder, with little or no effort at cost sharing. The department is requesting $15 million for work on the LDP, and has divided the money such that each nuclear architect engineer in the United States will have the opportunity of about the same amount of work. Possibly to avoid favoritism, this operation is being coordinated not by any nuclear firm, but by Boeing, a company that has no significant reactor experience. This $15 million runs counter to the Office of Management and Budget's order last year that all work on the LDP must be funded entirely by the private sector.

CONCLUSION

A new energy technology should not be moved to the demonstration phase merely because it is feasible and may supply energy. A demonstration should be funded only when it is clear that the technology can compete economically against existing alternative energy sources. This is true for any technology, not just for energy. Research is one thing, an expensive demonstration is quite another. Research and development on a supersonic transport (SST) airplane continues at NASA and the major aircraft manufacturers, for instance, but no demonstration project has gone forward because the commercial potential of the SST is far from certain.

Demonstrating a design too early carries a stiff economic penalty, as the British and French governments are now learning. They went ahead with the Concorde SST, which required massive subsidies and is now being abandoned as a commercial venture.