



UNITED STATES GENERAL ACCOUNTING OFFICE  
WASHINGTON, D.C. 20548

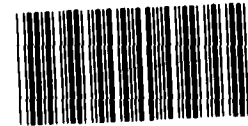
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ENERGY AND MINERALS  
DIVISION

September 23, 1982

B-164105

The Honorable John D. Dingell  
Chairman, Subcommittee on Oversight  
and Investigations  
Committee on Energy and Commerce  
House of Representatives



119621

Dear Mr. Chairman:

Subject: Interim Report on GAO's Review of the Total Cost  
Estimate for the Clinch River Breeder Reactor  
Project (GAO/EMD-82-131)

On April 28, 1982, you requested that we analyze the most current cost estimate for designing, constructing, and operating the Clinch River Breeder Reactor (CRBR). You requested that we include such factors as inflation rates, offsets, contingencies, and plutonium costs. Our analysis should be completed within the next few months. On August 31, 1982, you requested that we provide you with an interim report on our work. This report is in response to that request.

At your request, in order to provide the information you need on a timely basis, we did not obtain the Department of Energy's (DOE's) comments on this interim report. Information developed during the remainder of our analysis may, or may not, verify our preliminary findings. In addition, as discussed with your office, all financial information contained in this report is based on current dollars <sup>1/</sup> and our review included the costs included by DOE in the CRBR project cost estimate as well as other related costs incurred by the Government.

The following sections discuss (1) the process used by the DOE to estimate CRBR project costs; (2) the inflation allowance used in DOE's cost estimate, which could overstate CRBR costs; (3) the cost of plutonium, revenue projections, and contingency allowances, which may understate the total cost estimate; and (4) several items which are not included in the cost estimate but which, in our view, either will or could result in cost to the Government.

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<sup>1/</sup>The dollar value of a good or service in terms of prices current at the time the good or service is bought or sold. This is in contrast to the value of the good or service in constant dollars.

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One additional item which we have not examined but will explore during the remainder of our review is the residual value, if any, of the powerplant at the end of the demonstration.

DCE'S PROCESS FOR ESTIMATING  
CRER'S TOTAL PLANT COST

In 1973, the Atomic Energy Commission (AEC) 1/ entered into cooperative arrangements with the Tennessee Valley Authority (TVA), Commonwealth Edison, and the Project Management Corporation 2/ to design, construct, and operate, for a 5-year demonstration period, the Nation's first intermediate-scale liquid metal fast breeder reactor. This reactor, the CRER, was originally estimated to cost \$699 million. 3/ Since that original estimate, DOE, and its predecessor agencies, have revised the cost estimate six times. The most recent DCE cost estimate is about \$3.4 billion. About \$1.4 billion 3/ has been spent on the CRER through fiscal year 1982.

The original \$699 million cost estimate was based on preliminary data and required the use of many assumptions. For example, that estimate was based on contractors' proposals and assumed that the nuclear steam supply system could replace the boiler in an existing coal-fired powerplant. It also assumed that the plant would reach criticality 4/ in December 1979.

The most recent cost estimate was completed in March 1982. That estimate of \$3.365 billion assumed that pre-construction activities would begin in April 1982, and initial criticality would be in September 1988. 5/ A detailed summary of the March 1982 estimate follows:

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- 1/The Atomic Energy Commission was a predecessor agency to DOE.
  - 2/Project Management Corporation is a non-profit corporation which represents the interest of the utilities in the CRER project.
  - 3/Throughout this report, the total cost estimate includes the portion funded by private industry--currently estimated at \$351.5 million--and the Federal Government.
  - 4/Criticality is the state of a nuclear reaction when it is sustaining a chain reaction. This is the point when a nuclear powerplant is considered operational.
  - 5/The 5-year demonstration period will begin 6 to 7 months after criticality.

CRBR COST ESTIMATE  
(millions of current dollars)

	<u>Thru</u> <u>FY '81</u>	<u>FY '82</u>	<u>FY'83</u>	<u>FY '84</u> <u>thru</u> <u>FY '94</u>	<u>Total at</u> <u>completion</u>
Design, fabrication and/or purchase of the nuclear steam supply system	\$ 898.5	\$136.6	\$198.6	\$ 443.6	\$1,677.3
Design, fabrication and/or purchase of plant and non-reactor components	160.2	33.0	44.8	208.7	446.7
Plant construction and contingency	21.0	32.6	133.0	876.4	1,063.0
Fuel fabrication and contingency	.6	.7	2.3	267.8	271.4
Other overhead and support costs	67.9	15.1	18.1	166.5	267.6
Operations and maintenance	-	.6	.8	316.9	318.3
Revenue	-	-	-	(679.7)	(679.7)
<b>Total Costs</b>	<u>\$1,148.2</u>	<u>\$218.6</u>	<u>\$397.6</u>	<u>\$1,600.2</u>	<u>\$3,364.6</u>

Source: CRBR funding summary, March 1, 1982.

This estimate was developed by soliciting, in late 1981, estimates from the three prime contractors. Westinghouse Electric Company, responsible for the nuclear steam supply system estimated \$1,677 million as the total cost of this system. Burns and Roe, Incorporated, the architect-engineer, estimated \$446.7 million for its design work. The third prime contractor, Stone and Webster Engineering Corporation, responsible for building CRBR, estimated \$1,063 million for its construction work. The CRBR Project Office provided estimates on the cost of fuel fabrication and contingency, overhead and support, operations and maintenance, and revenues. DOE considers the \$3.365 billion an unofficial estimate.

Since March 1982, some of the basic assumptions have proven to be incorrect. For example, construction did not begin in April 1982, as planned, because the Nuclear Regulatory Commission (NRC) did not authorize DOE to start site preparation until August 1982. CRBR officials noted that each 1-month delay in getting the project underway adds about \$17 million to the project's costs.

In a September 15, 1982, letter responding to two congressmen, DOE revised the estimated cost of the CRBR to \$3.6 billion. This estimate is based on starting site preparation in September 1982, initial criticality in 1989, and fiscal year 1983 funding of \$252.5 million.

INFLATION ESTIMATES MAY  
OVERSTATE CRBR COSTS

The CRBR total cost estimate includes an annual allowance for inflation of 8 percent. In recent months, however, inflation has been at a rate which would be less than 8 percent. Estimating the rate of inflation in the future is speculative, at best. However, if recent trends continue, the CRBR total cost estimate may be overstated due to lower than estimated inflation. Conversely, if inflation increases, DOE's estimate may be appropriate. Based on our calculations, each 1-percent change in inflation would effect an overall change of about \$34 million, or about 1 percent in the total cost estimate.

ITEMS INCLUDED IN THE COST ESTIMATE  
THAT ARE, OR MAY BE UNDERSTATED

At this point in our work, we have found no reason to question the accuracy of many of the costs included in the CRBR total cost estimate. Three items, however, which are included in the estimate could cause an understatement of the estimate. They are

- the cost of the plutonium used to fuel the reactor,
- the estimated revenue from selling electricity generated by CRBR, and
- the allowance for construction contingencies.

The cost of plutonium to fuel the CRBR is understated

One of the costliest items directly related to operating the CRBR project is the plutonium needed to fuel the reactor. <sup>1/</sup> During the first 5 years of CRBR operation--the demonstration period --about 6.2 million grams of plutonium will be required to fuel the CRBR. The CRBR total cost estimate includes \$10 million for plutonium fuel. Depending on whether the plutonium comes from existing stockpiles or is produced in the future, its value could range from \$143 million to \$1.2 billion.

Although DOE officials have not specified exactly where they will acquire the necessary plutonium to fuel the CRBR, they identified several potential sources. These include DOE defense programs, which DOE breeder officials currently expect to provide all the necessary plutonium to fuel the CRBR, and two other potential future sources--reprocessing commercial nuclear spent fuel and/or foreign sources. The costs associated with acquiring plutonium from these sources not only vary widely but are also speculative.

Currently, the only domestic source of plutonium is DOE's defense programs. According to DOE, the defense programs could supply CRBR plutonium requirements from existing stockpiles, by producing it at existing production facilities, or some combination of the two. DOE defense programs officials, however, will not specify the exact source of any plutonium they might supply because to do so might reveal classified information related to national defense plutonium requirements. Additionally, defense programs officials told us that this Nation's defense needs could impact on their capability to supply the necessary plutonium.

The value of any plutonium supplied by DOE's defense programs would vary significantly depending on whether the plutonium is obtained from current stockpiles or produced at existing facilities. For example, substantial amounts of plutonium capable of fueling the CRBR have already been produced and stockpiled--some of it from the early 1970s. The value of this plutonium, according to DOE defense programs officials, is about \$23 per gram. On the other hand, according to these same officials, if plutonium for the CRBR is produced in 1984, or later, it would be valued at

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<sup>1/</sup>On September 17, 1982, we issued a report to the Chairman, Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce which dealt extensively with the cost of CRBR plutonium fuel. ("Information on the Cost of Plutonium Needed to Operate the Clinch River Breeder Reactor for its 5-Year Demonstration" (GAO/EMD-82-128)).

over \$200 per gram. Thus, the value of CRBR plutonium provided from DOE's defense programs could range from about \$143 million --if all the plutonium comes from existing inventories--to over \$1.2 billion--if all the plutonium required is produced after 1984. These officials told us, however, that if they had to provide all the plutonium from the defense programs facilities it would probably come from a combination of current inventories and future production. Thus, the value of any plutonium supplied would likely fall somewhere between the two estimates.

Defense programs officials also pointed out that they will expect the amount of plutonium provided to the CRBR project to eventually be returned to the defense programs from the plutonium produced and/or remaining from the CRBR's 5-year demonstration. In their view, therefore, the only cost to the Government for providing plutonium would be the cost to reprocess the CRBR spent fuel as a necessary step in reacquiring the plutonium. They estimated that if all the plutonium to fuel the CRBR were supplied from the defense programs such reprocessing would cost from about \$90 to \$120 million (1984 dollars). Although DOE defense programs officials acknowledge that there would be some additional costs such as storing and transporting the CRBR spent fuel, they do not believe this would add significantly to the above estimate. In addition, the above estimate does not include possible imputed interest cost to the Government that may occur in providing plutonium from the defense programs to the CRBR on an interim basis.

This approach does not, however, recognize that a provision in the NRC Authorization Bill for fiscal year 1982 and 1983 (H.R. 2330), now under consideration by the House/Senate Joint Conference Committee, might have a substantial impact on the planned transfer of plutonium produced by the CRBR to defense program uses. The Senate version of this bill would prohibit use of plutonium from NRC-licensed facilities in the manufacture of nuclear explosives. CRBR will be a NRC-licensed facility.

Another source of plutonium that may be available to DOE at some future time is reprocessed commercial nuclear reactor spent fuel. DOE officials estimate that the cost of plutonium from this source could range from \$15 to \$35 a gram. This cost range is based on DOE officials' preliminary estimates of prices they might be able to negotiate for reprocessing services. Thus, the cost range is speculative at this time. Furthermore, domestic capability for reprocessing commercial spent fuel does not now exist, and it is not clear whether it will be available to meet CRBR project schedule and plutonium requirements.

Finally, DOE officials stated that some plutonium, if needed, could be acquired from foreign sources. They added, however, that

this would involve high-level policy decisions and country-to-country negotiations. DOE officials said no negotiations are underway to acquire plutonium for the CRBR from foreign sources, nor are any related cost estimates currently available.

The cooperative agreements between the AEC, TVA, Commonwealth Edison, and Project Management Corporation obligated the AEC (later DOE) to provide the plutonium needed to fuel the CRBR's 5-year demonstration operation. DOE's Office of Nuclear Materials Production, under the Assistant Secretary for Defense Programs is responsible for meeting the Government's plutonium requirements. That office has traditionally provided plutonium at no charge to DOE's breeder program. While the cost of CRBR plutonium fuel may not be funded directly by CRBR funds, the Congress should be aware of the range of plutonium fuel costs which DOE may incur.

Revenue from sale of CRBR  
electricity may be overly  
optimistic

Included in DOE's CRBR total cost estimate as an offset to cost are the revenues anticipated from the sale of electricity to TVA during the 5-year demonstration period. We believe the CRBR revenue projections may be overstated--thus understating project costs--for two reasons:

- The estimated price of the electricity to be sold to TVA may be too high.
- The capacity factors 1/ assumed for the CRBR plant may be too high, resulting in an assumption of more electricity for sale than if lower, perhaps more reasonable capacity factors were used.

In the 1973 cooperative agreement, TVA contracted to buy the power produced by the CRBR. According to that contract, TVA will pay for the cost of the electricity that the CRBR plant replaces (i.e., the cost for TVA to produce that power at TVA facilities or buy it from other utilities).

TVA currently is capable of generating more electricity than needed. If that situation continues, and it appears likely, the purchase price, according to the contract, should be the cost of

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1/Capacity factor is ratio of the average power load of an electric powerplant in comparison to its maximum capacity, expressed in percent.

TVA production. TVA has computer models which can simulate the operation of its system and project costs several years into the future. In August 1981, at the request of CRBR officials, TVA used its models to supply CRBR officials with projections for its marginal cost of power during the 5-year demonstration period. However, CRBR officials did not use these estimates but instead calculated the expected revenues based on the amount TVA pays for electricity from cogenerators. 1/

DOE's use of cogeneration rates resulted in a \$679.7 million revenue estimate which was included in the total estimate as an offset against costs. Had CRBR used the marginal rates supplied by TVA, however, the expected revenue would have been \$626.8 million. Using the marginal rate supplied by TVA may be more realistic because it appears that CRBR power will be replacing TVA produced power. Thus, it appears that the total cost estimate may be overstated by about \$53 million due to overly optimistic price projections.

Further, to calculate expected revenues from CRBR operations, CRBR officials have assumed that the plant will operate at 75 percent of its capacity during the last half of the 5-year demonstration. CRBR officials informed us they are confident that the 75-percent capacity figure is realistic and, in fact, have a goal of 82-percent capacity. However, the assumption that the CRBR plant will achieve a 75-percent capacity factor that early in its operating life may be unrealistic. Light water reactor nuclear plants have experienced capacity factors that are considerably less than 75 percent. NRC reports show that the nuclear industry had an average capacity factor of 62 percent in 1979, 60 percent in 1980, and 61 percent in 1981. 2/ TVA, similarly projects a 65-percent capacity factor for its boiling water nuclear reactors and 61 percent for its pressurized water nuclear reactors.

The actual operating experience of the French Phenix breeder demonstration plant further indicates that 75 percent may be optimistic. According to an August 1981 Electric Power Research Institute report, the Phenix plant experienced a 58-percent capacity factor from the time it went into commercial operation in July 1974 through 1980. During the third, fourth, and fifth years of Phenix operation (comparable to the last 3 years of CRBR's 5-year

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1/Cogenerators are private electricity producers which sell excess power to TVA. The agreement with cogenerators provides for payment of a higher rate than the TVA marginal cost of production at TVA facilities.

2/Excluding the Three Mile Island-Unit II, Dresden-Unit I and Humbolt Bay; these plants may never return to service.



demonstration period), plant capacity was 16, 1/ 61, and 84 percent. During 1980 and 1981, its capacity was 65 and 71 percent, respectively.

Thus, we believe a conservative estimate of revenues using capacity factors based on the experience of the light water reactor industry (which is actually higher than the Phenix capacity average during a comparable period) would be more realistic than the estimate using capacity factors now assumed. Using a 63-percent factor (i.e., halfway between the 61- and 65-percent figures that TVA uses) and using the TVA supplied marginal costs, the revenue expected during the CRBR 5-year demonstration would be about \$120 million lower than the revenue estimate in DOE's current total cost estimate. The effect, since revenue is an offset, would be to increase the cost estimate by a similar amount.

Allowance for contingencies  
may be low

Included in CRBR's total cost estimate is \$90 million for construction contingencies. Total construction costs are estimated at \$973 million, making the contingency about 9.2 percent of the construction cost estimate. Based on the actual experience of the nuclear industry, the contingency estimate appears low, and thus, may understate the total cost estimate.

For example, TVA's construction estimates include a contingency allowance for the known scope of work plus an additional contingency allowance for possible future changes in scope. TVA officials told us this methodology is consistent with recent experience in the nuclear industry. The following table shows contingency allowances for three of TVA's conventional nuclear powerplants currently under construction.

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1/The capacity factor was low because of operational problems with the intermediate heat exchangers.

Construction Contingencies of Three TVA Nuclear Plants

	<u>Sequoyah</u>	<u>Watts Bar</u>	<u>Bellefonte</u>
Design (estimated percent complete)	97	77	78
Construction (estimated percent complete)	94	74	70
Estimated "probable" contingency (percent of remaining costs)	21	16	22

There are major differences in the planning for TVA plants and the CRBR which would perhaps account for some portion of the difference in contingency estimates. The CRBR design will be substantially completed prior to initial construction. In contrast, TVA begins construction prior to design completion. On the other hand, a great deal of experience has been gained in constructing commercial nuclear powerplants--72 plants are currently in operation in this country, 2 plants (5 reactor units) by TVA. Such past experience tends to add credibility to the higher contingency estimates employed by TVA.

Thus, based on TVA's experience, it appears that CRBR's contingency may be low. The CRBR figure also appears to be optimistic when one considers that CRBR is a first of a kind facility and that many licensing factors, which could require substantial design changes, remain unresolved. Nevertheless, it is difficult to make a definitive judgment on CRBR's construction contingency estimate at this time until we obtain additional information on such things as the experience of constructing other domestic light water reactors as well as foreign experience in building breeder reactors, such as the French Phenix and Super-Phenix.

ITEMS RELATED TO CRBR THAT ARE NOT INCLUDED IN THE COST ESTIMATE

Several items which are costs directly associated with the CRBR project are not included in the CRBR total cost estimate. These items are the salaries of Government employees assigned full-time to the CRBR project and the imputed interest on Federal funds used for the project. Further, there are certain other costs indirectly related to the CRBR project--such as the cost to eventually decommission the plant--which are costs associated with CRBR but, at this time, the amount is unknown.

Salaries of Federal employees  
are not included in the cost  
estimate

Since 1975, DOE and the Project Management Corporation have assigned employees to full-time positions in the CRBR project office in Oak Ridge, Tennessee. The personnel costs of the Project Management Corporation employees have been included in the project's estimated cost. The personnel costs of DOE employees assigned full-time to the CRBR project office, however, have not been included. Instead, these costs are charged to DOE's liquid metal fast breeder reactor program office in Germantown, Maryland.

In 1981, an average of 25 DOE full-time employees were assigned to the CRBR project. From 1976 through 1981, the salary costs for DOE employees totaled \$8.7 million. CRBR officials have not projected such costs through project completion. Making a conservative assumption that such salaries will be spent at the same rate through project completion, these costs could range from \$20 to \$30 million through 1994.

Thus the salaries of Project Management Corporation employees assigned to the CRBR project office are costs included in the total cost estimate, while \$20 to \$30 million in salaries for DOE employees assigned to the CRBR project office are not included in the cost estimate. During the remainder of our review, we will review Federal regulations and accounting principles to ascertain how other DOE and Federal projects account for salaries in order to better determine where these costs should be assigned.

Imputed interest not included  
in the cost estimate

The CRBR total cost estimate does not include imputed interest. Imputed interest is a non-expenditure item and is not normally associated with cost estimates. Imputed interest does, however, recognize the interest the U.S. Treasury pays on borrowed money used to fund Federal programs and projects.

Disbursements for the CRBR, as are nearly all Government disbursements, are made from a single pool of funds managed by the Treasury Department. In managing the Government's funding requirements, the Treasury Department does not earmark funds either by source or by use; instead, it is concerned with the total it must have available to meet all demands. When total receipts are insufficient to meet total demands, the Treasury obtains the difference through borrowing. The cost of interest from such borrowing can be attributed to an individual agency or project even though the agency will not actually incur the cost.

Cumulative net expenditure of Federal funds for the CRBR project will be about \$1.2 billion through fiscal year 1982, and according to CRBR information, will approach \$3.0 billion by the end of the demonstration period. Using the average yearly interest rate for 12-month Treasury bills, the cumulative imputed interest through fiscal year 1982 will exceed \$400 million. Based on projections of future interest rates, published by Data Resources, Inc., cumulative imputed interest on the CRBR project through 1994 (the end of the project's 5-year demonstration period) may exceed \$3.9 billion.

We discussed the use of imputed interest with DOE officials. They maintain that imputed interest is not a cost normally included in cost estimates for DCE projects and neither DCE nor Office of Management and Budget procedures require inclusion of imputed interest. We note, however, that DOE currently includes imputed interest as part of recoverable costs in DCE's enrichment activities and projects. In addition, the Federal Power Act (18 CFR 101) requires including an "allowance for funds used during construction" as a part of the estimated cost submitted to NRC to obtain a construction permit or operating license.

Although the cost of imputed interests is not a cost funded by DOE, the Congress should be aware that it is a cost to the Government.

The Congress should be aware  
of indirect CRBR costs

Congress should also be aware that decommissioning and technical support and testing are costs indirectly associated with CRBR but are not included in the total cost estimate. These items are discussed below.

1. Decommissioning. At the end of a reactor's life it must be decommissioned. The CRBR total cost estimate does not include this cost. DCE plans to offer to sell CRBR to TVA. If such a sale occurs, the Government would not directly incur any decommissioning cost. The Congress should be aware, however, that such cost could be incurred if TVA does not purchase CRBR.
2. Technical Support and Testing. Technical support and testing involve the assistance provided to CRBR through work performed as part of DOE's overall liquid metal fast breeder reactor program. For example, as part of the liquid metal fast breeder reactor program's evaluation of steam generator concepts, the CRBR steam generator will be tested at a cost of about \$15.3 million according to the test specification. No CRBR funds will

be expended on this testing, even though the CRBR program will benefit. While we do not believe the generic program costs should be reflected in the cost estimate, the Congress should be aware that such costs are not included and that such testing--which would have to be performed for CRBR regardless of the source of funds--is being funded by another program.

#### OBJECTIVES, SCOPE, AND METHODOLOGY

In performing this review, we have analyzed DOE's recently completed total cost estimate for the CRBR project. Specifically, we examined the process followed in creating the new total cost estimate. We have also considered the impact on the total cost estimate of such factors as (1) inflation, (2) demonstration period revenues, (3) contingency accounts, and (4) other CRBR related costs not included in the CRBR total cost estimate.

Regarding the inflation rates, we reviewed the total plant cost estimate inflation rate, current economic data, and tested the sensitivity of the total cost estimate to changes in the inflation rate. For information concerning the cost of plutonium, we relied on the work done during two other GAO Letter reports. <sup>1/</sup> Our work related to revenues involved reviewing and analyzing documents and holding discussions with TVA and CRBR officials. Our work involving contingencies, salaries, imputed interest, and the indirectly related items was performed by interviewing DOE officials, reviewing related documents, and comparing CRBR's handling of these items with the procedures used by other Government agencies and private utilities. As stated at the outset of this report, this is an interim status report, and completion of our work may or may not confirm the preliminary findings presented in this letter.

Our survey was performed in accordance with GAO's current "Standards for Audit of Governmental Organizations, Programs, Activities, and Functions."

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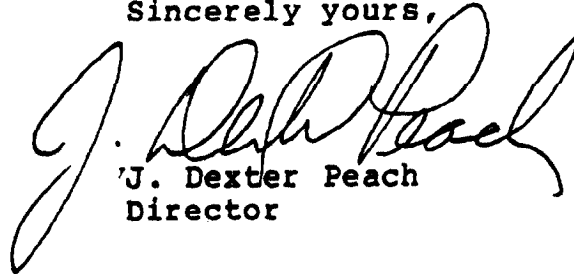
As requested by your office, we have not solicited DOE's review and comments on a draft of this letter. Also, as arranged

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<sup>1/</sup>"DOE Confident It Can Fuel the Clinch River Breeder Reactor and Other Breeder Reactor Projects" (GAC/EMD-82-89, May 14, 1982) and "Information on the Cost of Plutonium Needed to Operate the Clinch River Breeder Reactor For its 5-Year Demonstration" (GAC/EMD-82-128, September 17, 1982).

with your office, we will provide a copy of this report today to the Chairman, Subcommittee on Energy Research and Production, House Committee on Science and Technology. Unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of the report. At that time, we will send copies of the report to the Director, Office of Management and Budget; the Secretary of Energy; and to other interested parties and make copies available to others upon request.

Sincerely yours,

A handwritten signature in black ink, appearing to read "J. Dexter Peach". The signature is fluid and cursive, with a large initial "J" and a long, sweeping underline.

J. Dexter Peach  
Director