EM

THE SECRETARY OF ENERGY
WASHINGTON, D.C. 20585

March 15, 1983

Honorable Tom Bevill
Chairman, Subcommittee on
Energy and Water Development
Committee on Appropriations
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

The Conference Report (House Report No. 97-980) accompanying the Joint Resolution making further continuing appropriations for Fiscal Year 1983 (Public Law No. 97-377) contains the following language relating to the Clinch River Breeder Reactor Plant Project (CRBR).

> "Up to $1,000,000 shall be available to vigorously explore proposals including a reconsideration of the original cost-sharing arrangement, that would reduce Federal budget requirements for the Clinch River Project or project alternative, and secure greater participation from the private sector. The Department is to submit its findings to the cognizant congressional committees for consideration by not later than March 15, 1983.
>
> "The conferees strongly urge the cognizant authorizing committees in the House and the Senate to consider this issue early in the 98th Congress."

In response to this direction the Department of Energy requested the Breeder Reactor Corporation to form a Utility Task Force to identify and evaluate potential options for reducing Federal outlays by increasing private sector financial participation.

The quality and intensity of the utilities response to this task demonstrates their desire to augment project funding with private sources. Based upon my review of the Task Force report and discussion with members of the Task Force, there appears to be substantial electric utility support for continuing a breeder reactor program.

The Utility Task Force report is enclosed. Also enclosed is the Department of Energy Report that reviews the CRBR history and provides technical and financial data that serve as the basis for examining financial options. I am encouraged in that the Utility Task Force report offers several useful and promising ideas.

We believe that this report is responsive to the Congressional direction. The report does not contain a definitive proposal. Instead it deals with a range of possibilities primarily associated with financing based on the market value of the plant as an electrical energy producer. It is my understanding that more definitive discussions may now proceed, in conjunction with Congress, with potential parties to an expanded arrangement.

I look forward to undertaking that effort with you as soon as possible. I would appreciate your contacting Assistant Secretary Shelby Brewer when you are ready to proceed with further discussion.

Sincerely,

Donald Paul Hodel

DONALD PAUL HODEL

Enclosures

cc:
Honorable John T. Myers
Ranking Minority Member

DOE/NE-0050

REPORT TO THE CONGRESS ON ALTERNATIVE FINANCING OF THE CLINCH RIVER BREEDER REACTOR PLANT PROJECT

MARCH 1983

U.S. DEPARTMENT OF ENERGY
ASSISTANT SECRETARY FOR NUCLEAR ENERGY
OFFICE OF BREEDER REACTOR PROGRAMS
WASHINGTON, D.C. 20545

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EXECUTIVE SUMMARY

This report was prepared in response to Congressional direction in conjunction with the Further Continuing Appropriations Act for Fiscal Year 1983 (Pub. L. No. 97-377), which required that DOE explore alternatives for securing additional private sector financing for the Clinch River Breeder Reactor Plant (CRBRP) Project.

Our approach was to develop Government technical input concurrent with and for use in the development of financial alternatives by the private sector Utility Task Force organized under the auspices of the Breeder Reactor Corporation. The Utility Task Force concentrated on evaluating the financial aspects of various funding options from the private sector perspective.

The Utility Task Force report found that there is a wide range of possible alternatives for funding a portion of the CRBRP costs which could reduce Federal outlay requirements and attract significant private sector participation. These alternatives range from off-budget Federal guaranteed project financing, to user fees levied on electric generating utilities, to relatively traditional financing of the market value of the plant. The Task Force report considers the family of concepts that are based on seeking private investment commensurate with the market value of the CRBRP as the most viable alternative funding approach although it may be necessary to augment this concept with others of the discussed alternatives depending on the amount of private funding required.

The Utility Task Force has indicated that it intends to immediately proceed with discussions aimed at developing specific investment and marketing strategies. This will include developing both the structure of a private investment venture and beginning discussions with potential customers for CRBRP power.

Negotiations with the potential investors and customers and any necessary change to the existing four-party contract need to be vigorously pursued on a schedule that permits required legislation to be enacted by October 1, 1983.

- Background

  The Clinch River Breeder Reactor Plant (CRBRP) Project is a national research and development project. It is an integral part of the Liquid Metal Fast Breeder Reactor (LMFBR) program being conducted by the Department of Energy (DOE). The LMFBR has long been recognized as a virtually inexhaustible energy

option with the highest potential for meeting the future energy needs of the United States.

The CRBRP Project in Oak Ridge, Tennessee, is the nation's first large-scale demonstration breeder reactor. A breeder is a type of nuclear reactor that creates more fuel than it uses as it generates electricity.

CRBRP is a partnership effort of the U.S. Department of Energy, Commonwealth Edison Company, Tennessee Valley Authority, and Project Management Corporation, which represents the 753 utilities that have pledged to contribute $347 million including interest to the Project.

The Project is now ready to proceed to completion. Design is almost completed, over 70 percent of the equipment is on order or delivered, site preparation activities are underway, Project environmental hearings have been completed, and all aspects of licensing are proceeding rapidly. In late Calendar Year 1983, the Project expects to have the necessary Nuclear Regulatory Commission approvals to begin plant construction. Initial plant start-up is scheduled for late 1989 with the sale of significant quantities of electricity beginning in June 1990.

o DOE Studies

The Department established four principal objectives for the Utility Task Force:

1) increase private sector financing for CRBRP,

2) establish a stable and predictable financial basis for cost-effective completion of the project,

3) allocate project costs to research, engineering development and market values, and

4) partition risks associated with the project between those associated with any powerplant project and those associated with a unique developmental project.

The DOE has developed the technical and cost related information for the project in order to support the financial evaluation conducted by the Utility Task Force and to provide a technical basis for use by the Congress in evaluating alternative financing proposals. The DOE evaluation of Project Costs, Reliability, and Revenue Projections are contained in the appendices to this report.

The estimate of the additional funds required to complete the plant is approximately $2.3 billion for the period FY 1984 to June 1990 when significant revenues will begin from the sale of electricity. Since $.2 billion remains and is available from utility and contractor pledged contributions and interest, additional funding required from Government and private sources is about $2.1 billion. This information was utilized by the Utility Task Force in evaluating the amount of new private financing needed.

Operation and maintenance costs were projected for the 30-year life of the plant and adjusted to reflect recent experience by utilities in the operation of light water reactors particularly to reflect post-Three Mile Island experience. A conservative estimate of about $40 million per year (1983 dollars) in operating costs was developed.

The fuel cycle was analyzed and costs were estimated for supply of plutonium, fuel fabrication, fresh fuel shipping, CRBRP fuel reprocessing, and waste management. The DOE study concluded that there was considerable confidence in the availability of an adequate supply of plutonium and in the annual cost estimate of about $18 million (1983 dollars). Additionally, DOE assumed that nuclear waste would be handled in accordance with the Nuclear Waste Policy Act after 1998 and that a charge of 1 mill per KWH would be levied on CRBRP electricity in accordance with the Act.

The Project reliability, net output, and useful life were the subject of another study. This study concluded that the design goal of 82 percent availability and 75 percent capacity factor were reasonable and achievable but a 65 percent capacity factor after initial startup and shakedown were assumed for conservatism. The plant is conservatively designed for a 30-year useful life which is in accordance with industry standards. The plant will produce 330 MWe of net saleable power for the first 10 years and 380 MWe thereafter. These figures represent the effect of deducting power consumed in the operation of the plant which reduces the gross output of 375 MWe gross (430 MWe gross after 10 years).

A study was also performed of the need for new electrical generating capacity in the Southeastern United States in the 1990's and beyond. This study shows a need for over 16,000 MWe additional capacity to serve peak loads by 1995. CRBRP would provide only about 2 percent of this need. Since new plants in that region are planned to be coal-fired, projections of the cost of baseload electricity using coal as fuel were made which provided a range of 14.6¢ to 15.7¢ per KWH in 1991 in year of expenditure dollars.

- Utility Task Force Report

The category of financing which the Utility Task Force focused on to reduce Federal outlays and secure greater private participation is based on the value of the project as an electrical generating plant.

The Utility Task Force evaluated the reasonable bounds of private financing which could be forthcoming for this Project based on this "value". This analysis is based on the net cash flow expected to be available to the project from the sale of electricity and the benefits to equity investors in generating capacity.

Based upon the assumption that the electric revenue from the plant is equivalent to firm baseload capacity for a coal-fired plant, the Utility Task Force report concludes that income should be sufficient to cover operating costs plus an investment of as much as $1.1 billion (including debt, equity, and interest of about $300 million). The variables in the analysis which would affect the project's economic viability are the level of Government funding and amount of cash equity invested by the private sector.

The Utility Task Force has not recommended a single option but has identified a range of alternatives to be considered. The Task Force considers that there are many different ways to structure private investment in the Project. The Task Force also points out that while a number of Federal assurances and warranties are required many of these are contingent in nature and may never be actually called upon.

- Government Responsibilities

At present, the Government has assumed all the direct and indirect Project risks and financing requirements above the financial contributions of the utilities and others (a total of $347 million with interest). The Government-borne risks include those of Project completion, performance, licensing, and operation and maintenance during the 5-year demonstration period as well as long term operation and/or disposal of the facility if the Project cannot be sold or transferred as provided in the current project arrangements.

The Utility Task Force report concludes that the Government must continue to bear certain project risks in order to attract private investment which would place equity funds at risk and seek loans to cover a significant amount of the CRBRP capital costs. By continuing to carry these risks, the Government will be able to shift a considerable amount of the

financing from the public to the private sector. Government assurances or contingencies which may be required as described in the Task Force report include the following:

- long-term contracts for fuel supplies
- performance warranties
- assurances of continued Government funding for construction and demonstration purposes
- possible power purchase or marketing commitments.

Overall, the net effect of implementing private financing would be to significantly reduce the future Federal outlays required to complete the Project, and would provide a more stable and predictable funding for the Project.

o Legislative Action

In order to implement the general financing approach recommended by the Utility Task Force, modifications to the existing four-party contract between DOE, TVA, Commonwealth Edison, and Project Management Corporation would be required or at least additional arrangements among the principal parties and additional Congressional authorization or approval such as:

1. Appropriate authorization required for DOE funding for FY 1984-1990.
2. Modification to the existing cooperative arrangement to recognize the undertaking by DOE and private investors to fund and own the Project on a proportional basis.
3. Contractual authority which commits the Government to contingencies and risks which are beyond the normal investor risks.
4. Long-term market commitments for electric sales (based on debt services needed) to the extent long-term firm sales contracts are unavailable.
5. Long-term contracting authority.

The Department's experience in financial transactions indicates that a financial structure must be worked out with all the parties involved to assure that there is adequate protection to parties against a number of unforeseen contingencies. Therefore, the specific structure selected should await discussions with investors and lenders.

CHAPTER I

Introduction and Background

A. Introduction

The Clinch River Breeder Reactor Plant (CRBRP) Project is an endeavor of strong national importance. It is an integral part of the Liquid Metal Fast Breeder Reactor (LMFBR) program being conducted by the Department of Energy (DOE). The LMFBR has long been recognized as one of the energy options with the highest potential for meeting the future energy needs of the United States. The CRBRP Project is now at a crucial juncture. Design is almost completed, over 70 percent of the equipment is on order or delivered, site preparation activities are underway, Project environmental hearings have been completed, and all aspects of licensing are proceeding rapidly. In late Calendar Year 1983, the Project expects to have the necessary Nuclear Regulatory Commission approvals to begin plant construction.

Congress in conjunction with the Further Continuing Appropriations Act for Fiscal Year 1983 (Pub. L. No. 97-377), required that DOE vigorously evaluate alternatives for securing additional private sector financing for the Project. During the past 2 months, DOE and a Task Force formed under the auspices of the Breeder Reactor Corporation have been conducting such an evaluation and the results of these efforts are contained herein.

OBJECTIVES:

The Department has established four principal objectives for the Utility Task Force:

1) to increase private sector financing for CRBRP,

2) to establish a stable and predictable financial basis for cost effective completion of the project,

3) to allocate project costs to research, engineering development and market values, and

4) to partition risks associated with the project between those associated with any powerplant project and those associated with a unique developmental project.

Our approach was to develop Government technical input concurrent with and for use in the development of financial

alternatives by the Utility Task Force. The Government evaluations focused mainly on consideration of the relevance of the project's technical aspects while the Utility Task Force concentrated on evaluating the financial aspects of various funding options from the private sector perspective.

B. Background

This section briefly summarizes the background of the CRBRP project. Additional information is contained in Appendix A, Project Background and Existing Arrangements.

1. History of the Clinch River Project

Public Law No. 91-273 authorized the Atomic Energy Commission (AEC) to enter into cooperative arrangements with industry for the design, construction, and operation of a Liquid Metal Fast Breeder Reactor Plant in accordance with criteria submitted to the Joint Committee on Atomic Energy. On August 7, 1972, a Memorandum of Understanding (MOU) was entered into among AEC, The Tennessee Valley Authority (TVA), Project Management Corporation (PMC), Commonwealth Edison Company (CE), and Breeder Reactor Corporation (BRC) which generally stated the Project arrangements to be included ultimately in a definitive contract. PMC was to serve as the central management and contracting organization for the Project. BRC's role was to obtain financial and other participation of the 753 utilities contributing funds to the Project. The MOU contained an estimate of the cost of the Project at $699 million based on conceptual designs submitted by the three reactor manufacturers in their proposals to supply the plants' nuclear steam supply system. It also contained a commitment by AEC to seek additional funding if it appeared that the resources available to PMC were insufficient to permit continued effective conduct of the Project. Program Justification Data Arrangement No. 72-106, submitted to the Joint Committee on Atomic Energy (JCAE) on August 11, 1972, restated the AEC's commitment to seek additional funds for the Project if necessary, and also contained the $699 million cost estimate. It was recognized, however, both in the justification data and in JCAE hearings which followed, that the design of the plant was not yet firm and could change significantly.

A "four-party contract" for carrying out the Project (between AEC, TVA, CE and PMC) was executed on July 25, 1973. Under the terms of the four-party contract, PMC was authorized to manage the Project in accordance with agreed upon Project objectives. PMC was to use the utility-pledged contributions and AEC's funds for Project costs. The AEC, aside from providing direct funding assistance, was to furnish indirect assistance from the LMFBR Base Program, special nuclear materials and technical supervision and administration of the Nuclear Steam Supply System (NSSS) aspects of all contracts. The TVA was responsible for the lead role in planning for plant operation and maintenance and was also to provide personnel to fill certain key management positions in the Project. Under the contract TVA has the option to ultimately acquire title to the CRBRP after completion of the demonstration period. CE was to furnish the General Manager, the Project Manager, the Engineering Manager, and the Technical Services Manager as well as procurement and other services.

The four-party contract was modified in May 1976 to substantially realign the responsibilities of the parties. The impetus for the contract modification was the growth of the Government's investment relative to the utilities' investment. The modification, upon becoming effective, provided the Energy Research and Development Administration (ERDA) with the responsibility for the management of the Project and ownership of the plant. The parties agreed that PMC, while no longer directly managing the Project, would continue to administer the utilities' interests by monitoring the Project, preparing and sending out Project information to the BRC and the utility industry, arranging for participation of the utility personnel in the conduct of the Project, investing and disbursing the utilities' funds, and exercising the contractual rights on behalf of the utilities. TVA's responsibilities under the modified contract remained relatively unchanged except that TVA agreed to transfer custody of the plant site to ERDA rather than retaining such custody.

2. Cost Estimate Development

The four-party contract recognized that the design of the plant had not been selected on a detailed and firm basis. Therefore one of the first tasks embarked upon after execution of the four party contract was the establishment of a firm design and cost estimate for the Project. In

June 1974 a reference design for the Project was developed which was estimated at $1.736 billion with initial criticality projected in July 1982. The increase in estimated cost prompted the Government to seek, and Congress to authorize, the change in the Project arrangements transferring management responsibility to ERDA with support and assistance from PMC within an integrated Project Office composed of representatives of the Federal Government and the utility industry. This change in arrangements became effective May 1, 1976. Delays imposed on the Project by budget reductions, delays in the licensing process, and a further reassessment of the cost to complete the Project resulted in a 1975 reestimate of $1.95 billion, with a delay of 15 months in initial criticality to October 1983. The 1975 estimate remained the baseline until the previous Administration's decision in 1977 to suspend licensing activity and seek termination of the Project. Since 1977 the project cost estimate increased to $3.6 billion, and initial criticality was delayed to September 1989. In the FY 1983 continuing resolution Congress has directed DOE to explore proposals to reduce Federal budget requirements for the Project and to secure greater participation from the private sector.

3. Reasons for Cost Growth

Since the development of the initial CRBRP baseline cost estimate of $1.736 billion in 1974, more than 68 percent of the subsequent cost increases have been beyond the control of the Project. The majority, or 56 percent, is attributed to actions of the Government which have reduced the Government's funding profile for the Project, delayed completion, or threatened termination of the Project. Another 12 percent were cost increases due to requirements imposed by the Nuclear Regulatory Commission (NRC). Only 32 percent of the increase was theoretically within the control of the Project, and these resulted from the developmental nature of the Project.

4. Project Restart

The present Administration directed that the CRBRP be completed as expeditiously as possible. Accordingly, CRBRP funding was included in its FY 1982 budget request in the amount of $254 million. Congress authorized $228 million for the CRBRP in the Omnibus Budget Reconciliation Act of 1981, and appropriated $193.9 million for FY 1982.

The Conference Report, accompanying the Budget Reconciliation Act expressed the intent that:

> ***[T]he plant should be constructed in a timely and expeditious manner, so that a decision on the commercialization and deployment of breeder reactors can be made on the basis of information obtained in the operation of the plant. The plant should therefore be constructed on the basis of that objective, and not on the basis of providing needed power in the specific region of the Clinch River site.

In August 1981, DOE requested that NRC reestablish its review of Project safety documentation, and in September 1981, the NRC established a program office to conduct the licensing review of CRBRP.

5. Site Work

In response to President Reagan's direction that Government agencies proceed with demonstration of breeder reactor technology, including completion of Clinch River, DOE submitted to NRC a request for authorization to commence site preparation activities. The NRC denied the request on March 16, 1982, and also denied a subsequent request for reconsideration of its denial on May 14, 1982. A new request for authorization to commence site preparation activities was filed on July 1, 1982, and on August 17, 1982, NRC issued an order granting the request. Litigation initiated by intervenors both in the U.S. Court of Appeals for the District of Columbia and in the U.S. District Court for the Northern District of Georgia resulted in short delays as a result of injunctions issued by the courts. The D.C. Court lifted its own 2-day temporary stay when it denied an emergency stay of the NRC order authorizing site preparation. The ruling of the Georgia District Court that site preparation work could not commence prior to the issuance of a National Pollutant Discharge Elimination System Permit was reversed on appeal. Significant progress in site work has been made with completion of rock excavation scheduled for late September 1983.

6. Safety and Licensing

On June 11, 1982, NRC's updated Radiological Site Suitability Report for CRBRP concluded that the Clinch River site was suitable for a reactor of the general size

and type described in the Project's application. The Final Supplement to the Final Environmental Statement was issued by the NRC on November 3, 1982. Environmental hearings by the Atomic Safety and Licensing Board (ASLB) were concluded in January 1983 and on February 28, 1983, the ASLB issued a partial initial decision recommending a Limited Work Authorization. The NRC Safety Evaluation Report was issued on March 11, 1983. This will allow hearings to begin in early summer 1983 and permission to begin safety-related construction in November 1983.

7. FY 1983 Funding

Funding for Clinch River in FY 1983 is contained in the FY 1983 Continuing Resolution with certain restrictions as contained in the Conference Report. These restrictions generally limit the progress of plant construction and also directed the submission of this report to the cognizant congressional committees by not later than March 15, 1983.

CHAPTER II

DOE Studies and Synopsis of Utility Task Force Report

A. DOE Studies

DOE established a working group in January 1983 to conduct studies and develop information on the CRBRP Project which would be complementary to the financing analysis being conducted by the Breeder Reactor Corporation Utility Task Force. The information developed by this study is contained in this report and was used by the Utility Task Force in its study. The information will also be useful to the Congress in evaluating alternate financing proposals.

DOE's working group conducted studies in three principal areas:

- o Project Costs
  - Capital cost to complete
  - Operation and maintenance costs
  - Fuel cycle costs
- o Project Reliability
  - Plant availability and plant capacity factor
  - Power generation capability and useful life
- o Project Revenue Projections

The studies were performed with the assistance of outside technical experts as well as DOE's technical staff in Headquarters and the CRBRP Project Office. Contractors who contributed to the studies were S. M. Stoller Corporation, Technology for Energy Corporation (TEC), and Union Carbide Corporation, Oak Ridge National Laboratory. The appendices to this report contain the results of the DOE studies which are summarized below.

- o Capital Cost to Complete Project

  In March 1982 a detailed bottoms-up cost estimate for completion of CRBRP was concluded by DOE with agreement by the Project contractors. Two key assumptions were made that have since changed: NRC authorization to start site work was received in August 1982 rather than March 1982, and the FY 1982 and FY 1983 funding was approved by

Congress at about $194 million each year rather than higher levels assumed in the estimate.

An assessment of the impact of the above changes in assumptions has been made and there is a high degree of confidence that the cost to complete the Project after FY 1983 is $2.3 billion. Subtracting remaining utility and contractor contributions leaves about $2.1 billion as the amount of new financing required from the Government and private investors. The Utility Task Force utilized $2.4 billion due to differences in round off and consideration of budget carryover.

o Operation and Maintenance (O&M) Costs

Previous estimates have projected operation and maintenance costs in detail only through the 5-year demonstration period. With the assistance of the S. M. Stoller Corporation, DOE has studied the O&M costs which would be expected over the 30-year life of the plant. As a result, the estimate has been updated to include the results of current utility industry experience which reflects increased costs experienced in the last 2 years due to lessons learned from Three Mile Island. A conservative estimate based on light water reactor (LWR) experience was developed which accounts for fundamental differences between LWR's and LMFBR's but does not reflect substantially reduced operating costs which EBR-II and FFTF experience indicates may be achievable for LMFBR's. The average annual O&M cost in 1983 dollars is projected to be $39.4 million.

o Fuel Cycle Cost Analysis

DOE has analyzed the fuel cycle for CRBRP with an independent review by S. M. Stoller Corporation. The study looked at costs of plutonium supply, fuel fabrication, fresh fuel shipping, spent fuel reprocessing and waste management.

- Pu supply. It was concluded that plutonium can be obtained from reprocessing spent CRBRP fuel, spent LWR fuel, or by purchasing reprocessed plutonium. The cost is estimated at about $6 million per year in 1983 dollars.

- Fuel fabrication. Fuel will initially be fabricated at the Secure Automated Fabrication (SAF) line at the DOE Richland, Washington, facility. After the year 2005, it was assumed that the need for breeder fuel and plutonium recycle in light water reactors would be sufficient to

support a commercial fuel fabrication plant. Assuming a conservative learning curve for the fabrication costs in both Government-owned and private facilities, an estimate of $12 million per year in 1983 dollars was developed for fabrication of fuel and blanket assemblies, reflectors, and other replaceable core components.

- Fresh fuel shipping. Past experience in shipping fresh fuel was used to develop an estimate for shipping fresh fuel from Richland, Washington, to Oak Ridge, Tennessee, at an annual average cost of $180,000 (1983 dollars).

- Reprocessing CRBRP spent fuel. Reprocessing of CRBRP spent fuel was evaluated using an R&D reprocessing system, a commercial LWR reprocessing plant, and reprocessing overseas. The resulting estimate is that a cost of $7 per gram of fissile plutonium would result (1983 dollars).

- Waste management. It was assumed that after 1998, spent fuel and blanket assemblies would be provided for by the 1 mill per kilowatt hour charge under the Nuclear Waste Policy Act.

- Summary. Considering all of the above, the annual fuel cycle costs are estimated to be about $18 million plus a 1 mill/KWH surcharge for waste disposal.

o Project Reliability, Net Output, and Useful Life

Studies were performed in these areas by DOE with independent assessments by Technology for Energy Corporation. It was concluded that although CRBRP is a research and development project and the first-of-a-kind, it has been designed from the ground up as a highly reliable central station electric power generator. CRBRP has benefited from the latest approaches to systems engineering which the present generation of light water reactors did not. The result is that the entire plant has availability targets assigned to each system and an overall goal of 82 percent. This goal and the planned 75 percent plant capacity factor were verified by TEC. Nevertheless, in making revenue projections for purposes of this study, DOE recommended that a conservative 65 percent capacity factor be assumed which is similar to LWR experience.

Additionally, the DOE studies support the use of a 30-year planned lifetime for the plant. The net output (saleable power) is assumed to be 330 megawatts electric (MWe) for the first 10 years of life (375 MWe gross less 45 MWe maximum "hotel" load) and 380 MWe net thereafter. All of the plant components have adequate margin to operate at 430 MWe gross which is 380 MWe net after deducting 50 MWe for "hotel" load at full design power.

- Revenue Projections

DOE was assisted in studying the projected need for new capacity in the region surrounding Oak Ridge, Tennessee, by the S. M. Stoller Corporation and the Oak Ridge National Laboratory. S. M. Stoller Corporation conducted a survey of utilities and ORNL did extensive research using this existing detailed data base and a thorough literature search.

The results of the studies identified the need for new capacity in the Southeastern Reliability Council (SERC) area. Except for Florida, the entire region is considered within transmission range of CRBRP. The area is projected to require 16,000 MWe of additional capacity to serve peak demand periods by 1995. The CRBRP output would displace only about 2 percent of the projected new demand in 1995.

Utilities are expected to provide for new capacity requirements in the near future with coal-fired baseload generating stations. To build a single coal-fired 350 MWe plant (comparable to the CRBRP output) utilities are projected to spend $584 million (1984 dollars) for a plant going on line in 1991.

An analysis of the cost of baseload electricity using coal as fuel was performed for the period during which CRBRP will operate. Analyses covered a range of cost projections between 14.6¢ and 15.7¢ per KWH in 1991 in year of expenditure dollars.

B. Utility Task Force Report

The Task Force performed a financial evaluation of various funding options for completing CRBRP from the perspective of the private sector.

Following are the key conclusions reached by the Utility Task Force:

1. $1.1 billion can be raised in new-source funding which includes about $300 million in interest. This would displace about $800 million in costs which would otherwise be funded by the Government under the existing arrangements and would reduce the remaining Government appropriations to complete the Project to about $1.4 billion. In addition, under existing arrangements, U.S. utilities and project contractors will contribute almost $200 million more as research and development expenditures.

2. Private funding will be obtained partially by capitalizing on the market value of the plant's electrical output and partially through the availability of those Project-related tax incentives normally available to private investors.

3. Congress, DOE, and the private investors must ensure that funding for remaining work is timely and sufficient to maintain construction schedules because of the significant cost impact of schedule slippages.

4. Legislation is required to ensure Federal funding in the amounts and on the schedule needed to support construction. Federal commitments regarding completion, licensing, and operation of the plant will also be needed to make private investment possible.

5. Regulated utilities in the Southeastern United States may be able to use CRBRP power to displace some new capacity which is projected to be required in the 1990's and beyond. The present regulatory climate and difficulty of projecting electricity costs 10 years from now make it unlikely that the customers for the CRBRP power could contract for firm prices today. Accordingly, some type of Federal action may be required to assure an adequate resource stream from power sales.

6. Private financing could be facilitated through creation of a new entity such as a joint venture in which the Federal Government and private investors could join as partners. This arrangement would be similar to those used for financing other large construction projects and would allow allocation of tax benefits among the private partners.

7. The Utility Task Force has not recommended a single option but has identified a range of alternatives to be considered. The Task Force considers that there are many different ways to structure private investment in the Project. The Task Force also points out that while a number of Federal assurances and warranties are required many of these are contingent in nature and may never be actually called upon.

CHAPTER III

Next Steps

This report provides the results of the effort by DOE and the BRC Utility Task Force to evaluate alternatives for securing additional private sector financing for CRBRP. The Utility Task Force Report concludes that there is a substantial market value for the CRBRP over and above the Project's research and development value such that a large private capital investment in the Project is feasible. In the time available for the study, however, it was not possible to enter into discussions with potential customers for the power output from the Clinch River plant, with potential investors for the Project, or to structure specific arrangements to facilitate private financing.

The utility industry intends to immediately proceed with discussions aimed at developing specific investment and marketing strategies. This will include developing both the structure of a private investment venture and to begin discussions with potential customers for CRBRP power. Since a most important element of maximizing the commercial value of the Project is to sell electricity as firm baseload capacity, it is possible that one of the best approaches to marketing the power will be for the customers for firm capacity to participate in the private entity or entities investing in the Project.

Based on preliminary discussions, the three major prime contractors on CRBRP, Westinghouse, Stone & Webster Engineering Corporation, and Burns and Roe, Inc., expect to participate in discussions regarding formation of appropriate structures for private investment. Until such discussions take place, it is not possible to predict whether any or all of those companies would actually join as investors in the Project. Decisions by these and other potential investors are necessarily dependent upon development of more specific structures and they also depend upon the final form of legislative authority provided to DOE. In addition, various factors may constrain participation by these companies under existing law.

Negotiations with the potential investors and customers and any necessary changes to the existing four-party contract need to be pursued on a schedule that permits required legislation to be enacted by October 1, 1983.

APPENDIX A

Project Background and Existing Arrangements

A. BACKGROUND

1. History of the Clinch River Project

The Clinch River Breeder Reactor Plant Project (CRBRP or "the Project") has its antecedents in the Atomic Energy Commission (AEC) Authorization Act For Fiscal Year 1970 (Pub. L. No. 91-44) which authorized AEC to conduct the "project definition phase" of a liquid metal fast breeder reactor demonstration program under cooperative arrangements with reactor manufacturers and others. The basic CRBRP authorization followed 1 year later in the AEC Authorization Act For Fiscal Year 1971 (Pub. L. No. 91-273) which authorized AEC to enter into cooperative arrangements for the design, construction, and operation of the plant in accordance with criteria submitted to the Joint Committee on Atomic Energy (JCAE). The AEC Authorization Act For Fiscal Year 1972, Pub. L. No. 92-84, increased the Government's participation in the Project by increasing direct assistance funding and by increasing the assistance allowed from the base program to 50 percent of the estimated capital cost of the plant.

In 1972, in contemplation of entering into agreements with the AEC for the Project, the Breeder Reactor Corporation (BRC) and Project Management Corporation (PMC) were incorporated. BRC's role was to obtain financial and other participation of the 753 utilities contributing funds to the CRBRP. PMC was to serve as the central management and contracting organization for the Project.

A memorandum of understanding was executed among AEC, BRC, PMC, the Tennessee Valley Authority (TVA), and the Commonwealth Edison Company (CE) in August 1972 which specified the basic project arrangements to be included ultimately in a definitive contract. The memorandum of understanding specified the Project cost estimate as $699 million based on the conceptual designs submitted by reactor manufacturers in their proposals to supply the plant's nuclear steam supply system. The memorandum of understanding also contained a commitment by AEC to endeavor to obtain additional funds for the Project if it appeared that the resources available to PMC were

insufficient to permit continued effective conduct of the Project.

Pursuant to the statutory authorization for the Project, the AEC presented to the JCAE a description of the principal features constituting the bases for the contemplated arrangement for construction and operation of the plant in a Program Justification Data Arrangement, No. 72-106, dated August 11, 1972. The Justification Data restated the AEC's commitment to seek additional funds for the project if necessary, and also contained the $699 million cost estimate. It was recognized, however, that the design of the plant was not yet firm, and the estimated cost could be changed when a more definitive basis for revision was available. After conducting hearings, the JCAE agreed that the proposed arrangement was in accord with the requirements of the enabling statute, section 106 of Public Law Number 91-273, as amended by Public Law Number 92-84.

2. Cost Estimate Development

A four-party contract (AEC, TVA, CE, and PMC) for carrying out the Project, Contract AT(49-18)-12, was then negotiated and presented to the JCAE in early 1973. The parties recognized that there could be significant, but unavoidable, uncertainties regarding a preliminary estimate for a research and development project. Therefore, after the execution of the four-party contract on July 25, 1973, one of the first tasks embarked upon was the establishment of a firm design basis and cost estimate for the Project. As a result of the completion of a reference design in June 1974 the first baseline project cost estimate of $1.736 billion was established along with a reference schedule for initial criticality in July 1982, based upon site clearing commencing on September 1, 1975. This cost estimate as well as the Project cost estimates previously submitted to the Congress were based on the cost of constructing the CRBRP and conducting a 5-year demonstration program during which time the electricity generated would be sold to offset total Project costs.

As a result of this increase in the Project cost, in 1975 Congress authorized a change in the arrangement among the four parties to the basic contract. This change established that the Federal Government would manage the Project with support and assistance from PMC within an integrated Project Office composed of representatives of the Federal Government and the utility industry. This change in arrangement became effective May 1, 1976.

In 1975, the Project cost estimate was reassessed at $1.95 billion, with a delay of 15 months in initial criticality to October 1983. This action was the result of delays imposed on the Project from reductions in budget needed to maintain the schedule developed in 1974, delays in the licensing process, and a further reassessment of the cost to complete the Project. The 1975 Project cost estimate revisions remained as the baseline cost and schedule until the decision by the previous Administration in 1977 to suspend licensing activity and seek termination of the Project. Since 1977, the estimate increased to $3.6 billion, and initial criticality was delayed to September 1989. Following these revisions in cost and initial criticality, Congress passed the FY 1983 continuing resolution with direction in the report of the Conference Committee (H.R. Rep. No. 97-980 at 186, 97th Cong. 2d Sess. December 20, 1982) to "explore proposals, including a reconsideration of the original cost-sharing arrangement, that would reduce Federal budget requirements for the Clinch River Project or project alternative, and secure greater participation from the private sector." The funding provided by the continuing resolution for 1983 for the CRBRP is $193.9 million. Since this funding is below that required by the $3.6 billion estimate, a newly revised assessment of the cost to complete the plant, described in Appendix B of this report, is being prepared that will assist in the exploration of proposals.

3. Reasons for Cost Growth

Since the development of the initial CRBRP baseline cost estimate of $1.736 billion in 1974, more than 68 percent of the subsequent cost increases have been beyond the control of the Project. The majority, or 56 percent, is attributed to actions of the Government which have stretched out the Government's funding profile below that required to support the Project schedule, delayed completion, or threatened termination of the Project. Another 12 percent were cost increases due to requirements imposed by the Nuclear Regulatory Commission (NRC). Only 32 percent of the estimated Project cost increases were theoretically within the control of the Project, and resulted from the developmental nature of the Project. It is extremely inefficient and costly to delay or extend a large project once work is well under way and thousands of workers employed. The externally-imposed delays on the Project are clearly responsible for most of the cost growth and result from the combined effects of inflation and costs of maintaining management and supporting organizations over a longer period than would be needed to complete the job without constraints.

Following is a summary of the cost increases beyond the original $1.736 billion baseline estimate:

ESTIMATED PROJECT INCREASES FROM 1974 BASELINE
DUE TO FUNDING LIMITATIONS AND LICENSING

	Cost Impact ($ Millions)	Schedule Impact (No. Months)
Cost Increases Due to Funding Levels Below Those Required to Support the Project Schedule:		
Reduction in Funding Required by Baseline Schedule	$ 117[1]	12
Proposed Termination by the Previous Administration from April 1977	694[2]	56
Recent Licensing/Funding Limitations:		
FY 1982	235[3]	12
FY 1983	14[4]	1
NRC/Licensing Requirements:		
1974 Delay in the Licensing Process	78[5]	7
All Other	140[6]	
Total	$ 1,278	88

Notes:

1/ The $117 million in funding limitations prior to April 1977 consists of $90 million (8 months schedule delay) due to FY 1976 funding limitations (part of the cost growth from $1.736 billion to $1.95 billion) and $27 million (4 months schedule delay) due to the FY 1978 initial funding reduction (in February 1977 from $235 million to $150 million).

2/ The impact of a subsequent FY 1978 funding reduction after April 1977 (from $150 million to $80 million) and the subsequent funding reductions through Fy 1981 resulted in $694 million increased costs (56 months schedule delay).

3/ The combined impact in FY 1982 of delaying the start of site work from April 1982 to September 1982 (based on NRC action on the 10 CFR §50.12 request) and the funding limitations (from the $353 million required to support start of site work in April 1982 to the $194 million actually received) resulted in $235 million increased costs (12 months schedule delay).

4/ The combined impact of actual FY 1983 funding (reduction from $227 million to $194 million) resulted in $14 million increased cost and one month schedule delay.

5/ In 1973, based on a decision from the U.S. Court of Appeals for the District of Columbia Circuit, the Scientists' Institute for Public Information was successful in requiring AEC to submit an environmental report on the Liquid Metal Fast Breeder Reactor Program. The $1.736 baseline estimate was prepared in 1974 prior to the court decision. The environmental issue delayed the licensing process and resulted in $78 million increased costs (7 months schedule delay).

6/ Other NRC/licensing requirements increased the costs by $140 million. These increases include (1) additional design, analysis, and plant changes to demonstrate the suitability of CRBRP to sustain an increased seismic load from 0.18g to 0.25g, (2) increased design, analysis, and plant modifications to demonstrate acceptable site boundary doses for the source term, and (3) added design, analysis, and plant hardware revisions to demonstrate acceptable margins for core disruptive accidents.

Approximately $611 million (32 percent) of the increased costs is attributable to the Project. This $611 million is applicable to all Project elements (design, hardware, construction, operations and maintenance, fuel) and includes the following examples:

- Hardware increases resulting from inaccurate initial estimates and fabrication problems.

- Engineering and management increases resulting from more stringent project control practices, inaccurate initial estimates, and design changes.

- Construction increases resulting from design omissions, bulk quantity changes due to design evolution, added quality assurance and quality control activities, and inaccurate initial estimates.

Some of this increase includes improvements to keep technology up to date and advance the state of the art and design changes which will facilitate construction activities. These improvements include:

a. Incorporation of heterogeneous core into the design, a very significant design improvement for the following reasons:

   (1) It results in a breeding ratio of 1.3 that not only exceeds the CRBRP design goal (1.2) but also easily surpasses that of Phenix (1.14), Super Phenix (1.2), or any other LMFBR in the world;

   (2) It simultaneously reduces the fuel sodium void coefficient roughly by half, greatly enhancing the ability to demonstrate increased safety margins for hypothetical core disruptive accidents;

   (3) It provides a degree of flexibility for accommodating alternate fuel cycles (such as uranium/thorium) and fuel management variations of interest to utilities (such as the improved economics associated with longer fuel lifetimes, as advanced materials become available);

   (4) It permits usage of the poorer grades of plutonium (high Pu-240 content) that have no strategic value for the United States; and

(5) It reduces fuel costs by substituting less expensive blanket assemblies for some of the fuel assemblies required by the previous homogeneous core.

b. Incorporation into the design of many advances in the state-of-the-art, e.g., multiplexing of monitoring and control functions, advanced techniques for computer redundancy and distributed processing, application of advanced leak detection techniques, and use of state-of-the-art solid state programmable logic for the control and action of safety-related equipment; and the addition of new features such as automated generation of effluent reports to the NRC, ultra high sensitivity source range flux monitoring, and integrated incorporation of post-TMI requirements (including a plant simulator, expanded accident monitoring equipment, emergency response facilities, emergency planning, and increased emphasis on human factors in control room design).

c. Advanced planning of construction activities from final design documentation which will result in significant reduction in construction delays. The constructor was able to perform extensive constructability reviews for developing timesaving plans in areas considered difficult to construct. Models and erection drawings have been developed for such activities as excavation of nuclear island, reactor cavity area, cell liners, reinforcing steel, equipment installation using unique lifting equipment, etc. The advanced stage of planning has allowed for a disciplined interchange of information between designer and constructor.

d. Changes brought about by lessons learned from TMI and a detailed review of the key CRBRP Plant Safety systems, which provided particular attention to the operations, maintenance, and test aspects of the design to assure that these functions could be carried out without adverse safety consequences.

As the preceding figures show, chief among the Government actions contributing to cost increases and schedule delays was the decision of the previous Administration to seek termination of the Project. On February 23, 1977, at the President's direction, the Energy Research and Development Administration (ERDA), the successor agency to AEC, undertook to review the LMFBR program in general and the CRBRP in particular. For the review, ERDA

utilized a committee composed of individuals of widely differing views about both nuclear energy and the breeder program. The review committee's report concluded that a demonstration plant of the approximate size of CRBRP was necessary and that the CRBRP objectives were appropriate to that plant. Nevertheless, on April 20, 1977, the previous Administration announced its decision to cancel the Project. Shortly thereafter, ERDA filed a motion with the NRC Atomic Safety and Licensing Board requesting an indefinite suspension of the hearings on the Project's application for a Limited Work Authorization.

Notwithstanding the decision of the previous Administration to cancel CRBRP, the Congress continued to provide funds for the Project although at an amount below that required to keep the Project on its baseline schedule. The funding provided by Congress permitted continuation of design efforts and fabrication of plant components already ordered. Licensing was suspended, construction could not begin, and new procurements of plant components were restricted.

4. Project Re-Start

The present Administration recognized the importance of the breeder reactor to our energy future and directed that the CRBRP be completed as expeditiously as possible. Accordingly, CRBRP funding was included in its FY 1982 budget request in the amount of $254 million. Congress, however, authorized $228 million for the CRBRP in the Omnibus Budget Reconciliation Act of 1981, Public Law Number 97-35 and appropriated $193.9 million for FY 1982, Public Law Number 97-88 and Conference Report No. 97-345. House Conference Report No. 97-208, accompanying the Budget Reconcilation Act (Pub. L. No. 97-35) expressed the intent that:

> ***[T]he plant should be constructed in a timely and expeditious manner, so that a decision on the commercialization and deployment of breeder reactors can be made on the basis of information obtained in the operation of the plant. The plant should therefore be constructed on the basis of that objective, and not on the basis of providing needed power in the specific region of the Clinch River site.

In August 1981, DOE requested that NRC reestablish its review of Project safety documentation, and in September 1981, the NRC established a program office to conduct the licensing review of CRBRP.

5. Site Work

President Reagan in his Nuclear Policy Statement on October 8, 1981, directed that "government agencies proceed with a demonstration of breeder reactor technology, including completion of the Clinch River Breeder Reactor." In response to this direction, the Department of Energy (DOE), for itself and on behalf of its co-applicants, PMC and TVA, requested the NRC to authorize site preparation activities pursuant to 10 CFR §50.12. The NRC denied the initial request in a 3 to 2 decision. DOE requested reconsideration of that decision on May 14, 1982, which was denied by a 2-2 vote. Thereafter, on July 1, 1982, DOE, PMC, and TVA filed a new request for authorization to conduct site preparation activities. In connection with the new request, the parties provided an updated assessment of the impact of site preparation activities and showed that the grant of the request would advance the schedule for completing CRBRP by 6 to 12 months. In addition, detailed analyses established that granting the request and acceleration of Project completion would: (1) yield substantial informational benefits to the LMFBR program; (2) enhance the effectiveness of the Administration's international nuclear program objectives; and (3) avoid substantial adverse impacts in both of the foregoing areas.

The NRC subsequently, by a 3 to 1 majority vote granted the Section 50.12 request. On August 17, 1982, it issued an Order granting the request to begin site preparation activities. In accordance with the NRC order, the construction contractor promptly awarded a subcontract to begin site work. However, the Natural Resources Defense Council (NRDC) and the Sierra Club, intervenors in the NRC licensing proceedings, petitioned the United States Court of Appeals for the District of Columbia Circuit on August 19 for review of the NRC Order. In addition, NRDC sought to invalidate a memorandum of understanding between DOE and the Environmental Protection Agency (EPA) in the U.S. District Court for the Northern District of Georgia. This memorandum of understanding allowed site preparation work to begin prior to issuance of a National Pollutant Discharge Elimination System Permit. The District Court enjoined the start of site preparation work. That order was promptly overturned by the U.S. Court of Appeals for the Eleventh Circuit on September 21, 1982, and site work began the next day.

On October 4, 1982, the U.S. Court of Appeals for the District of Columbia Circuit in its review of the NRC Order, ordered a temporary stay of the effectiveness of the NRC Order pending its determination as to whether an emergency stay should be granted. Two days later, the court decided that an emergency stay would not be granted and lifted the temporary stay. The court then held a hearing on NRDC's petition and on December 2, 1982, ruled that the NRC should have held an adjudicatory hearing on the Section 50.12 request and ordered NRC to do so. The court, however, did not enjoin site preparation activities. On December 7, the court withdrew its opinion and order of December 2 and issued a modified opinion and order. The modified order no longer mandated an adjudicatory hearing but required NRC to either conduct such a hearing or to reconsider the availability of Section 50.12. The court ordered that site preparation activities could continue subject to the further order of the court or of the NRC. By Order dated January 5, 1983, the NRC, in a 3 to 2 decision, reaffirmed its earlier order authorizing site preparation activities.

Considerable progress has been made on site preparation under the 10 CFR §50,12 authorization. Mass excavation started on December 21, 1982. Completion of the rock excavation is now scheduled for late September 1983. Placement of leveling and mud mats will begin in October 1983; assembly and lifting of rebar modules into place will begin in November 1983; and placement of structural concrete for the nuclear island mat will begin in December 1983.

6. Licensing and Safety

On June 11, 1982, the NRC staff issued its update to the 1977 radiological Site Suitability Report for CRBRP. This report concluded that, from the standpoint of radiological health and safety, the Clinch River site was suitable for a reactor of the general size and type described in the application. The Final Supplement to the Final Environmental Statement was issued by the NRC on November 2, 1982. The NRC Atomic Safety and Licensing Board (ASLB) conducted full environmental hearings in Oak Ridge, Tennessee, beginning August 23, 1982, and ending in January 1983. The ASLB issued a partial initial decision dated February 28, 1983, recommending issuance of a Limited Work Authorization.

The NRC Safety Evaluation Report was issued on March 11, 1983. This will allow hearings to begin in early summer 1983 leading toward permission to begin safety related construction in November 1983.

7. FY 1983 Funding

During the consideration of DOE's FY 1983 budget request, the CRBRP received a great deal of attention in the appropriation process. The conference committee report on the FY 1983 continuing resolution (Pub. L. No. 97-377) described the House-Senate agreement to continue funding the Project and stated:

"1. The Department will not initiate construction of any permanent facility structures or place any additional major equipment orders during the period of this resolution.

2. Ongoing activities related to the NRC licensing process should be continued.

3. The current rate of Federal funding for the Clinch River Project shall be determined so as to take into account the anticipated $19,000,000 available from non-Federal contributions in 1983.

4. Up to $1,000,000 shall be available to vigorously explore proposals including a reconsideration of the original cost-sharing arrangement, that would reduce Federal budget requirements for the Clinch River Project or project alternative, and secure greater participation from the private sector. The Department is to submit its findings to the cognizant congressional committees for consideration by not later than March 15, 1983.

The conferees strongly urge the cognizant authorizing committees in the House and the Senate to consider this issue early in the 98th Congress."

B. EXISTING ARRANGEMENTS

The existing arrangements for the CRBRP, in effect since May 1976, are based on a four-party contract, executed on July 25, 1973. Under the terms of the 1973 four-party contract, PMC was authorized to manage the Project through a Project Steering Committee, to which CE, AEC, and TVA each appointed one member, and in accordance with agreed upon Project objectives PMC was to use the utility-pledged contributions ($257,000,000) and AEC's funds for Project costs. The AEC, aside from providing direct and indirect funding assistance, was to furnish special nuclear materials and technical supervision and administration of the Nuclear Steam Supply System (NSSS) aspects of all contracts. TVA was responsible for the lead role in planning for plant operation and maintenance and was also to provide personnel to fill certain key management positions in the Project. Under the contract TVA had the option to ultimately acquire title to the CRBRP after completion of the demonstration period. CE was to furnish the General Manager, the Project Manager, the Engineering Manager, and the Technical Services Manager as well as procurement and other services.

The contributions made by the members of the utility industry, including CE and TVA, did not entitle contributors to any unique benefits which were unavailable to noncontributing utilities. Contributors obtained no beneficial ownership interest in the plant; no exclusive rights to patents, data, copyrights, processes or technical information (although contributors as well as other noncontributing utilities receive a non-exclusive royalty-free license); and no financial return on their investment. Even the right to assign employees to the Project was available to noncontributing utilities on an equal basis with contributing utilities.

The four-party contract was modified in May 1976 to substantially realign the responsibilities of the parties. The impetus for the contract modification was the growth of the Government investment relative to the utilities' investment.

Revisions to the authorizing legislation permitting the proposed changes were made in Pub. L. No. 94-187 and in the Statutory Criteria and Program Justification Data. The modification, upon becoming effective, provided ERDA with the responsibility for the management of the Project and ownership of the plant. The parties agreed that PMC, while no longer directly managing the Project, would continue to administer the utilities' interests by monitoring the Project, preparing and sending out Project information to the BRC and the utility industry, arranging for participation of the

utility personnel in the conduct of the Project, investing and disbursing the utilities' funds and exercising the contractual rights on behalf of the utilities. TVA's responsibilities under the modified contract remained relatively unchanged except that TVA agreed to transfer custody of the plant site to ERDA rather than retaining such custody.

APPENDIX B

Project Costs

In order to conduct meaningful analyses of private investment scenarios the costs to complete the Project must be accurately known and the costs to operate Clinch River over its lifetime must be understood. This Appendix addresses these costs.

I. Capital Cost To Complete Project

The estimate of capital costs is based on an in-depth assessment of a detailed cost estimate prepared in 1982 which assumed that NRC would authorize site work to begin in March 1982. This detailed cost estimate was a complete "bottoms-up" estimate of the costs to go based on achievable schedule milestones. The detailed estimate of the costs to go was negotiated with and concurred in by the Project's principal contractors. NRC authorization to begin site work, a major milestone for the Project, was not received until August 1982. This change in the start of site work required associated adjustments to the earlier detailed Project cost and schedule estimates. An assessment of the impact of the delay to August 1982 in the start of site work and of the the impact of anticipated funding limitations in FY 1983 and FY 1984) resulted in a revised estimated net cost to go of about $2.2 billion and delay of initial criticality to September 1989. This was the last assessment of estimated costs prior to the FY 1983 continuing resolution.

Subsequently, preparation of another cost assessment (rather than a detailed "bottoms-up" cost estimate) has been initiated for this report. Since the actual funding level in FY 1983 is $193M, the planned pace and sequence of work which would have led to initial criticality in September 1989 has been impacted and initial criticality is now assumed to be October 1989. This revised estimate excludes revenues and operating costs during the 5-year demonstration. The differences in the estimates to complete the plant for initial criticality in September 1989 and October 1989 are due to the 1 month delay caused by reduced FY 1983 funding and by a more conservative estimating technique for operation and maintenance costs. The present assessment (that is ongoing) indicates that the impact of these events is a $25 million increase in costs, resulting from:

Cost of Escalation and Stretch-out	$14 million
More Conservative O&M Estimate	11 million
	$25 million

Those cost increases have been factored into the capital cost estimate.

The estimate for the additional funds required to complete the plant and operate the plant until June 1990 is about $2.3 billion (for the period FY 1984 to June 1990, See Table B-1 for the display of this $2.3 billion by category of work per fiscal year.)

There is a high degree of confidence in this preliminary assessment of the range of the expected cost of these delays. Analyses of cost estimation in new technologies have shown that a cost estimate is indeed "definitive" when project engineering is complete, contracts have been costed, schedules have been established, and construction is ready to begin. At that point, estimates are expected to be within plus or minus 5 percent of actual plant costs (A Review of Cost Estimation in New Technologies, Rand Corporation, Santa Monica, California, July 1979). For CRBRP, the design of the plant is almost complete and approximately 70 percent of the plant equipment is either delivered or on order. The schedule has been established and site preparation is in progress. Because of the advanced state of the CRBRP design at the start of construction, cost uncertainties from internal causes are greatly reduced.

The following key bases and assumptions were used in developing the cost assessment:

a. The estimate is expressed in year-of-expenditure dollars; that is, an estimate of an 8 percent annual inflation rate has been included.

b. The estimate includes all costs to design, procure equipment, and construct the plant, and the cost of operating the plant until June 1990.

c. The estimate is based on a CRBRP schedule that reflects start of site work in September 1982 and continued progress towards initial criticality in 1989.

d. The estimate assumes receipt of necessary approvals from NRC in a timely manner; this includes issuance of an

TABLE B-1

CRBRP CAPITAL COST ESTIMATE TO COMPLETE CONSTRUCTION
IN MILLIONS OF YEAR OF EXPENDITURE DOLLARS
1989 CRITICALITY

	FY84	FY85	FY86	FY87	FY88	FY89	FY90	TOTAL FY84 THRU MAY 1990
RM ENGR/MGMT	78.7	57.3	28.0	16.4	13.4	11.1	2.6	207.5
RM HARDWARE	123.7	145.1	74.6	16.8	1.7	.8		362.7
AE ENGR/MGMT	26.5	25.1	11.4	8.5	7.4	7.9	1.9	88.7
AE HARDWARE	23.0	86.4	45.9	8.7	.1			164.1
CONSTRUCTION (CN)	143.6	233.3	317.3	200.0	121.8	(13.9)		1,002.1
CN CONTINGENCY	12.9	25.9	23.2	18.5	9.5			90.0
LABS	.1	.1						.2
FUEL/SNM	2.9	10.3	29.0	36.8	25.9	42.2	39.7	186.8
FUEL CONTINGENCY	.3	.9	3.6	5.6	10.6	8.4	7.9	37.3
PROJECT OFFICE	13.0	12.0	11.9	12.3	12.7	12.4	7.3	81.6
OPNS/MAINT (O&M)	.8	6.0	11.4	14.0	20.1	29.3	27.9	109.5
REVENUE							(33.7)	(33.7)
OTHER CONTINGENCY	10.2	20.5	15.5	13.0	11.3	9.1	9.0	88.6
TOTAL COSTS	435.7	622.9	571.8	350.6	234.5	107.3	62.6	2,385.4
TOTAL FUNDS REQUIRED[1/]	499.0	656.9	516.6	321.5	202.7	96.1	47.0	2,339.8
UTIL. CONTRIB[2/]	20.7	23.8	23.8	22.8	21.0	21.0	39.0	172.1
OTHER CONTRIB.	1.4	.2	.2	.2			2.5	4.5
NET FUNDS REQUIRED	476.9	632.9	492.6	298.5	181.7	75.1	5.5	2,163.2

1/ Total Costs of $2,385.4 minus funds available to start FY84 of $45.6 = $2,339.8 funds required.

2/ Assumes utilization of all utility contributions prior to commercial operations.

March 3, 1983

authorization to start safety-related construction activities by November 1983.

e. Funding as needed to optimize construction after FY 1983 is assumed.

II. Operation and Maintenance Costs

The operation and maintenance (O&M) costs in the previous CRBRP cost estimates have been updated for this assessment. The estimate includes the following costs:

a. Plant Operation and Maintenance--On-site permanent operating staff, home office support, field service staff, O&M materials and supplies, licensing fees, downtime electric power consumption, contingent fund for plant modifications and improvements;

b. Insurance and Taxes--Nuclear liability insurance, property damage insurance, and property taxes (to the extent applicable); and

c. Decommissioning Fund.

The operating and maintenance costs were derived by adjusting experience data (1980) based primarily on TVA nuclear plants and moderated where necessary by experience at Duke Power and Commonwealth Edison. Adjustments were made to account for a significant increase in O&M costs experienced by utilities in the past two years, caused principally by incorporating lessons learned from Three Mile Island. TVA supplied input on its latest O&M requirements, and S. M. Stoller Corporation and ORNL each reviewed the estimate independently.

TVA's operational experience was used as the primary basis for developing applicable O&M requirements for CRBRP. These costs were adjusted to account for size and complexity between CRBRP and TVA plants. This LWR operating experience, modified to reflect fundamental design differences, is considered applicable to CRBRP for the following basic reasons:

a. CRBRP will be operated as a power generating station for baseload generation.

b. The general regulatory requirements and the same specific requirements applicable to LWRs (except when design differences dictate otherwise) will apply to CRBRP.

c. The utility operator will have personnel trained and conditioned in LWR systems so that existing satisfactory

operating practices will be appropriately incorporated into the operation of CRBRP.

d. Although the electric generating capacity of the CRBRP is smaller, the physical size of the plant is comparable to a large LWR unit whose operating experience was used as the reference. Also, because it contains an intermediate loop, the plant contains a comparable quantity of piping, valves, cable, instrumentation, and components.

The above conditions justify using the experience in LWRs at TVA, augmented by that of Duke Power and Commonwealth Edison, as a base for developing CRBRP O&M estimates.

However, the CRBRP has fundamental differences from the LWRs used as reference, so they were carefully analyzed and accounted for. These differences are:

a. Basic reactor technology, i.e., sodium-cooled systems with an intermediate heat transfer loop as compared to an open or closed cycle water-cooled system. These conceptual differences define the size of the physical plant, coolant handling and purification, transport of radioactivity to plant systems, area environments, and component accessibility. These conditions also dictate differences in maintenance planning, techniques, and operations.

b. CRBRP is a first-of-a-kind plant while the reference LWR plants are, at least, third generation.

The details of LWR O&M cost experience were analyzed to determine the applications directly appropriate to CRBRP and which must be modified for use. The reviews of TVA, S. M. Stoller Corporation, and ORNL focused on modification of previous O&M experience on LWRs. The determination of O&M costs for the CRBRP is shown in Table B-2.

The experience with LWRs for on-site permanent operating staff and office support was adjusted only for physical size and CRBRP's classification as a single unit plant. The field services staff (labor and materials) for normal outages were modified to account for plant layout, care regarding sodium coolant, radioactivity level, and compartments filled with inert gas. It was assumed that special tools for carrying out inspections and tests where sodium was involved would be properly provided.

Operating supplies and non-outage maintenance materials were also analyzed to account for specific design differences, e.g., sodium coolant, intermediate loops, differences in handling and processing coolant leakage, compartments

TABLE B-2

CRBRP O&M COST ESTIMATE SUMMARY

IN MILLIONS OF 1983 $

		Major Refueling Outage Year	Alternate Year Minor Refueling Outage
I.	TVA Division of Nuclear Power (Operating Division)		
	A. On-site Permanent Operating Staff (Labor)	$12.2	$12.2
	B. Home Office Support (Labor and Materials)	1.9	1.9
	C. Field Services Staff (Outage)		
	Maintenance Expense	5.5	3.0
	Capital Improvements and Modifications	5.5	-
	D. Operating Supplies and Maintenance Materials	4.7	4.7
	E. Contingency @ 5% on the above O&M Expenses	1.5	1.1
	TOTAL	$31.3	$22.9
II.	Support from Other TVA Divisions	$ 4.3	$ 4.3
III.	Miscellaneous Expenses		
	A. Licensing	$ 0.2	$ 0.2
	B. Nuclear Liability Ins.	0.4	0.4
	C. Decommissioning	1.8	1.8
	D. Property Damage Insurance	2.3	2.3
	E. Local Taxes	3.3	3.3
	TOTAL	$ 8.0	$ 8.0
	TOTAL I, II, and III	$43.6	$35.2

Average = $39.4

filled with inert gas, minimal liquid radwaste system (and its impact on the solid radwaste system), and plant capacity.

In addition to the base costs of O&M discussed above, general costs (for example, licensing and insurance) were estimated. This expense, in part, was based on LWR experience. An estimating contingency of 5 percent was added to the estimated costs of the operating division, shown as Item I in Table B-2. This 5 percent is considered adequate when combined with a fund of $2.7 million per year for plant modifications and improvements as shown in Item I.C. of Table B-2.

The NRC licensing fee expense was included based on the existing NRC fee schedule. Nuclear liability insurance was based on the assumption that the entire plant would be covered by this insurance.

In estimating property damage insurance costs, LWR premium rates were applied to the private investment share of CRBRP. A decommissioning fund was included as part of the operating expense to accrue at $1.8 million per year (1983 $), approximating the amount currently being set aside by TVA for its PWR units. This should be more than adequate because worldwide LMFBR experience has shown significantly lower levels of contamination and activation for LMFBRs than for LWRs.

It was assumed that the private ownership interest would not be exempt from local property taxes as is the Federal Government's interest. A new taxable investment of the size contemplated here would probably enable DOE to cease providing financial assistance to the City of Oak Ridge and Roane County, Tennessee, under the Atomic Energy Community Act. In FY 1983 such payments are budgeted for $3.3 million. This amount was included in the cost estimate as the local property tax. Under the terms of a self-sufficiency agreement with the City and County, DOE will reduce its assistance payments if the tax base is increased.

Based on the CRBRP design personnel staffing assumptions and projections extrapolated from actual EBR-II and Fast Flux Test Facility (FFTF) operating experience to CRBRP size, the LMFBR operating cost experience indicates the potential for substantially reduced operating and maintenance costs (compared with the current LWR experience assumptions used). Projections based on LMFBR experience could lead to an annual savings in operating and maintenance costs of upwards of $10 million.

For sensitivity purposes, the case assuming a $10 million reduction was treated relative to the net revenue calculations which assume LWR experience.

III. CRBRP Fuel Cycle Cost Analysis

In evaluating the fuel cycle costs and availability for the extended operation of CRBRP, various options were investigated with the goal of demonstrating a basis for confidence that complete fuel cycle services will be available to CRBRP over its lifetime at reasonable cost.

The CRBRP fuel cycle includes mixed oxide fuel fabrication, blanket element fabrication, reprocessing, management of the wastes generated by facilities in the fuel cycle and transportation of wastes and products among the various facilities.

The program plan for the CRBRP is to reprocess the CRBRP fuel assemblies to recover the plutonium for recycle back to the CRBRP. For purposes of this analysis, however, a range of alternative fuel cycles were reviewed.

During the 5-year demonstration period, the CRBRP project goals will be achieved regardless of the fuel cycle used for the long term. The actual fuel cycle used after the 5-year demonstration period will depend on the availability of services and fuel and the economics at that time.

Any examination of the nuclear fuel cycle must be based on a realistic assessment of present and projected availability and costs of fuel and the associated costs of fabrication, shipment, reprocessing, and waste management. The following describes the results of the analysis of those elements as they relate to the CRBRP. The results of both DOE's analysis and an independent review by the S. M. Stoller Corporation support the conclusion that it is realistic to project that plutonium fuel will be available through reprocessing of breeder fuel or commercially from LWR reprocessing at a cost that will not affect the cost projections presented herein, and that fuel can be fabricated and can be reprocessed or stored at a reasonable cost for the life of the plant.

The goal of the breeder development and demonstration program has always been centered around demonstrating powerplant technology through a series of increasingly larger demonstration plants (of which CRBRP is a key element) and to demonstrate closure of the breeder fuel cycle. For years, we have conducted extensive R&D in breeder reprocessing and fuel fabrication technology as an essential element of the breeder research and development program.

These efforts have led to the development of advanced reprocessing equipment and processes and in the design of breeder reprocessing equipment with remote handling and maintenance capability. The building of a small scale breeder fuel reprocessing system as a

research and development activity to conduct engineering tests of the reprocessing of breeder reactor fuel is being investigated. Such a system should be operational in time to serve all of CRBRP's needs. Reprocessing of breeder fuel in conventional reactor reprocessing facilities could be done by blending the breeder fuel with greater quantities of conventional low enriched uranium fuel. This approach would likely require the addition of equipment at the front end of such a reprocessing facility to shear and leach the breeder fuel. As a result of the R&D program in fuel fabrication, the Secure Automated Fabrication line is being constructed at the Hanford Engineering Development Laboratory. This facility is intended to demonstrate remote and automated fabrication of breeder fuel for health and safeguards control and to demonstrate the economics of breeder fuel fabrication. This facility is an integral part of the breeder technology development program which will meet the fuel fabrication needs for FFTF and can provide fuel fabrication services as needed for CRBRP at cost. The facility is scheduled to become operational in 1986.

Plutonium Supply

This part of the analysis examines the availability and cost of plutonium for fuel over the life of the plant. Factors indicate that there will be quantities of plutonium available that will be considerably in excess of the requirements for plutonium to fuel the CRBRP for the 30 year life of the plant.

It has always been the goal and plan to reprocess the CRBRP fuel. As is discussed in more detail in the section dealing with reprocessing of CRBRP fuel, for the purpose of this study several options were identified to reprocess the CRBRP fuel and the costs of the various options examined. The costs varied from less than $500 to about $1,000 (1983 dollars) per kilogram of heavy metal. It was therefore conservative to conclude that CRBRP fuel should be able to be reprocessed at a cost of $1,000 per kilogram of heavy metal. Since the average plutonium content of discharged CRBRP fuel is about 17.7 percent, the cost of plutonium from reprocessing would therefore be about $5.65 per gram of plutonium containing 19 percent plutonium-240, or $7 per gram of fissile plutonium recovered.

The analysis ignores the fact that DOE is developing and testing advanced reprocessing concepts to demonstrate less expensive and more reliable reprocessing. This development program should make a significant contribution to improving the economics of breeder reactors and to improving the economics of the CRBRP fuel cycle. It is reasonable to project that over the life of the CRBRP, the cost of reprocessing plutonium from the CRBRP should improve significantly.

In the 25-year post-demonstration period, plutonium should be in plentiful supply on the world market. This is based on projections of the availability of reprocessing capability. The reprocessing plant capacity, currently operating or being constructed, is about 3,000 tonnes per year (Reference 1). This could increase substantially as suggested by recent French analyses showing projections of the growth rate of reprocessing capacity (Reference 2). Previous studies by the Working Groups of the International Nuclear Fuel Cycle Evaluation (Reference 3) also provide analysis supporting a projected growth in reprocessing sufficient to provide plentiful plutonium. By 1996 reprocessing activities throughout the world should produce substantial quantities of plutonium every year.

A plutonium market exists (Reference 4). In 1982 plutonium was selling at $6 to $9 per gram fissile. The current and predicted market price through 1984 is $4 to $6 per gram fissile. Current and planned reprocessing activities will result in a substantial amount of plutonium being made available. The future price of plutonium will be determined by market forces that will result from factors such as the price of uranium ore, the rate of growth of breeder reactors, and the extent of use of plutonium recycle in LWR's. For conservatism, no benefit was included in the analysis for expected improvements in the economics of reprocessing, of potential credits from sale of plutonium bred in the CRBRP or for recovering and selling the plutonium contained in CRBRP spent fuel and blanket assemblies at the end of the 30-year operating life.

The CRBRP core design has a number of parameters that can be varied to meet the cost variables produced by the marketplace. No such optimization was performed for this analysis. The operation of the blanket assemblies and the breeding performance will be demonstrated in the 5-year demonstration period. For subsequent operation, when the objective would be to maximize revenues, consideration has been given to not reprocessing the radial blanket assemblies during the post demonstration 25-year operation. These assemblies could either be discharged to a waste repository or nickel reflector assemblies could be substituted for the radial blanket assemblies. Therefore, at any time after the 5-year demonstration phase, the optimal economic decisions for the blanket can be determined based on the market price of plutonium and reprocessing costs at that time.

For purposes of this study, the total costs of plutonium for the 25-year post-demonstration period were projected to be about $150 million (1983 dollars) or about $6 million per year (1983 dollars). This is higher than the expected cost of either reprocessing or purchases at the current market price.

In summary, a basis exists for confidence that sufficient plutonium will be available to provide fuel for CRBRP at a reasonable cost.

Fuel Fabrication

Fuel for the CRBRP will initially be fabricated at the Secure Automated Fuel (SAF) line in Richland, Washington. This fuel line will be operated to supply the developmental fuel needs of FFTF and the breeder reactor program regardless of CRBRP needs. The fabrication costs of CRBRP fuel will be based on the actual operating and materials costs at the facility.

The goal of the breeder reactor fuels development program is to extend the lifetime of fuel and to reduce the fuel fabrication costs. This program has been, and continues to be extremely successful. Current results provide a strong basis for confidence that this program will continue to achieve its goals. The fuel for the CRBRP is quite similar to the FFTF fuel. The key difference is that the CRBRP fuel assembly is 14 feet long as compared to 12 feet in the FFTF. The CRBRP can directly use the results of FFTF experience in the fabrication of fuel and fuel performance. This provides a firm understanding of the costs of producing fuel and of ways to reduce this cost, based on considerable experience fabricating FFTF fuel. The base technology program includes a number of fuel development activities that are currently demonstrating the achievement of increased fuel lifetime and performance.

Breeder reactor development activities that are expected to reduce fuel fabrication costs and to benefit the initial and subsequent cores required for the 25-year post-demonstration period include:

- improvements in the fuel fabrication process
- development of means to achieve improved efficiency and increase reliability
- optimization of specification requirements based on operating experience

Examination of the fabrication costs and process parameters show that it is reasonable to project that the initial fabrication costs should be reduced by at least 20 percent by the time it is necessary to fabricate the fuel for the fourth core loading (1993 to 1994). Use of a 20 to 30 metric tonne per year mixed oxide fabrication plant operating at or near capacity would reduce the fabrication cost to a level that is 40 percent of the initial fuel fabrication costs due to the economics of scale by 2005. It was assumed that the need for breeder reactor fuel and plutonium

recycle could reasonably be expected to support construction and operation of such a plant in the year 2005. This capacity would be sufficient to fuel the CRBRP, a large scale breeder, and to provide a modest amount of plutonium recycle fuel to LWR's.

Worldwide experience in advanced breeder fuels strongly suggests the advanced fuels capable of higher burnups will be available. These fuels are currently under active development and should be available after the end of the 5-year demonstration period.

The average annual fuel fabrication costs are about $12 million (1983 dollars) per year. This includes the fuel, blankets, reflectors, and other replaceable core components.

Fresh Fuel Shipping

The costs of shipping fresh fuel from the fabrication facility and return of the empty casks were examined. Experience allows the costs of shipping to be predicted from experience with fresh fuel for other plants.

The costs are based on shipment of fresh fuel from Richland, Washington, to Oak Ridge, Tennessee, a distance of approximately 2,400 miles.

The fresh fuel shipping costs were conservatively calculated to be about $3,400 per fuel assembly (1983 $). In addition, about 10 casks costing $30,000 each will be required. The fresh fuel shipping costs are projected to be about $180,000 per year.

These costs are higher than present day costs for shipping LWR fuel assemblies. Since breeder reactor fuel contains over 20 percent reactor grade plutonium, Safe Secure Transport (SST) type services will be used.

The costs for shipping each assembly represents less than 2 percent of the cost of the assembly itself.

Reprocessing CRBRP Spent Fuel

The program plan for the CRBRP is to reprocess CRBRP fuel for recycle back to the plant. However, for the purposes of this study, several possible alternatives for the reprocessing of breeder reactor fuel were identified and the associated costs were examined.

Among the possible alternatives are the following:

- Reprocessing using a research and development system to perform engineering tests of reprocessing breeder reactor fuel. The breeder reactor fuel reprocessing research and

development program has designed and fabricated equipment to conduct "cold" tests of reprocessing of breeder reactor fuel in a small integrated reprocessing plant. This "cold" test plant is being used to perfect the equipment design and obtain operating and maintenance information using non-radioactive material. This experience provides the basis for the design of a "hot" installation that would conduct engineering test by reprocessing fully irradiated fast breeder fuels. The system being considered would handle about 15 metric tonnes per year. The purpose is the testing of a small integrated reprocessing plant that includes provisions for equipment maintenance, waste management, and the most advanced state of the art effluent control and safeguards and security in an environment approaching that expected in commercial practice. This system represents a natural progression in the fuel cycle program. Program results to date on activities such as the cold tests provide a good basis for estimating the cost of building and operating this system. The system is required for the breeder reactor reprocessing program and is independent of the future of the CRBRP. The reprocessing costs of this option are based on the actual operating costs that are projected to be $15 million per year. Since the capacity is 15 metric tonnes, the cost of reprocessing would be $1,000 per kilogram of heavy metal processed or about $7 per gram of fissile plutonium recovered.

- o Reprocessing in a commercial LWR reprocessing plant. Various types of plants were considered (Reference 5). In the lowest cost plant the reprocessing cost could be as low as $250 per kilogram of heavy metal, or about $1.80 per gram of fissile plutonium recovered. This is based on a plant design and cost study made by Exxon (The Economics of Reprocessing Alternative Nuclear Fuels, September 1979). In the most expensive case the cost could be $500 to $700 per kilogram of heavy metal reprocessed or about $3.50 to $5.00 per gram of fissile plutonium recovered. This is based on a 1978 DuPont study (Design Integration Study--Spent LWR Fuel Recycle complex, September 1979). The upper end assumes private ownership. Reprocessing of breeder fuel in these facilities could entail a somewhat higher cost than reprocessing LWR fuel.

- o Reprocessing in foreign nations. The cost of this option based on the world trend should be less than $7 per gram fissile.

The costs for the reprocessing of breeder reactor fuel varied between less than $500 per kilogram to $1,000 per kilogram of

heavy metal. That equates to a cost of between less than $3 and $7 per gram of fissile plutonium recovered, respectively.

Research and development activities underway could result in reduction in these costs. As commercial use of breeder reactors increases, it is reasonable to assume that commercial facilities to reprocess breeder reactor fuel will be available at a price that should be less than the cost used in this examination. For conservatism these potential cost benefits were ignored.

Based on this examination a cost of $7 per gram of fissile plutonium was used to project the cost of a variety of options for plutonium supply including reprocessing.

Waste Management

Waste disposal will be provided at reasonable cost irrespective of the actual fuel cycle used for the CRBRP. The Nuclear Waste Policy Act provides for all spent fuel and blanket shipping and storage, beginning in 1998, as well as for the storage of high level waste that would result from reprocessing CRBRP fuel or blanket material. The cost is 1 mil per kilowatt hour of electricity sold pursuant to the Act.

The first three cores used in the CRBRP will be a part of the demonstration period. The fourth core will be the first post-demonstration period core. This core and subsequent cores will be removed after 1998, and thus are immediately provided for by the Nuclear Waste Policy Act. The on-site facilities that are a part of the CRBRP include provision to store two cores, plus a portion of a third core.

Currently available spent fuel shipping casks could be modified to ship CRBRP fuel. This assumes that the fuel is cleaned of sodium prior to shipment. The largest shipping cost that can be envisioned would be if the spent fuel were shipped to Richland, Washington. The costs of such shipment would be about $4,000 (1983 dollars) per assembly. The costs of shipment to the Savannah River Plant would be about $1,000 (1983 dollars) per assembly. These costs are between about 0.5 percent and 2 percent of the fuel assembly costs and would apply at a maximum to the first three cores.

Description of Key Analytic Assumptions

From the foregoing, the analysis assumed:

- An average price of $7 per gram of plutonium fissile from plutonium reprocessing or purchase

- Fabrication of fuel in SAF-line to the year 2005
- Fabrication of fuel in a commercial facility after the year 2005
- Improvement in the fuel life time from 550 full power days to 825 full power days after the completion of the demonstration period.

The potential cost benefits that might be achieved by taking advantage of beneficial changes in reprocessing prices and plutonium price changes were not used.

The analysis ignored a number of factors that could result in lowered fuel cycle costs and does not consider the implementation of certain options that could result in lower costs.

The costs in 1983 dollars resulting from this analysis are:

- Plutonium supply--$150 million total, or an average of about $6 million per year.
- Fuel fabrication--$300 million total or an average of about $12 million per year.
- Fresh fuel shipment--$4 million total or about $180,000 per year.
- Reprocessing cost--zero, all costs of reprocessing are allocated to plutonium supply.
- Waste Management--This cost will be 1 mill per kilowatt hour and is provided by the Nuclear Waste Policy Act after 1998.

Generally conservative assumptions that were used in this analysis are:

- Commercial fabrication of fuel assemblies is not available until the year 2005.
- No credits are taken for bred plutonium or recovery of any of the plutonium used, or produced, in the 25-year post demonstration period.
- No credit is taken for the development of the market conditions that would favor the commercial introduction of breeder reactors in the United States, and improve the economics of the CRBRP fuel cycle.

Summary and Conclusions

The fuel cycle analysis indicates:

- A viable fuel cycle for the CRBRP will be available over the life of the plant.

- There is therefore a basis for confidence that the actual CRBRP fuel cycle cost should not be significantly different than projected, and that the fuel cycle costs uncertainties will not adversely affect the economics of long term operation of the CRBRP.

REFERENCES

1. The International Nuclear Fuel Cycle Fact Book, PNL-3594, Rev. 1, Pacific Northwest Laboratory, February 1982.

2. Castaing Report--"Report of the Working Group on Spent Fuel Management, dated December 1982.

3. The Reports of The Working Groups on the International Nuclear Fuel Cycle Evaluation, dated January 1980.

4. Nuclear Assurance Corporation Report, Near-Term Plutonium Market, March 1983.

5. "Nuclear Energy Cost Data Base," DOE/NE-0044, Version 1, dated October 1982.

APPENDIX C

Project Reliability

I. Plant Availability/Capacity Factor

1. Introduction

An independent assessment of the CRBRP availability program was conducted by the Technology for Energy Corporation (TEC). TEC has verified the conclusion that the CRBRP availability goal of 82 percent is achievable after the initial shakedown period and that specifically a 75 percent capacity factor after the first few years of operation is reasonable and realistic. The CRBRP availability program was judged to be unique among U.S. reactors in that high availability was a design basis from the inception of the Project. Each system was allocated an availability target and each system design was assessed against the target to identify and correct the unavailability drivers. All major critical CRBRP components have been extensively tested at and beyond the design basis with full life cycle testing on major key components.

The activities reported in this paper are those that TEC considers above and beyond industry standard practices.

The DOE and TEC summary conclusions are based on the following findings:

a. The CRBRP goal of an average 20 days per year of refueling should result in at least an improvement of .05 in availability factor over previous LMFBR's and LWR's. A high confidence level is placed on the current projection of slightly over 17 days per year average refueling time.

b. One of the largest unknowns in a first-of-a-kind nuclear plant is fuel reliability. The CRBRP fuel will have undergone years of in-core testing in test reactors at conditions representative of CRBRP operation.

c. Balance of Plant (BOP) scheduled maintenance and inspection are not on the critical path for any scheduled outages.

d. A Westinghouse availability assessment for CRBRP resulted in an average 25 days per year (7 percent unavailability) for all scheduled outages including refueling, inspection, surveillance, and preventive maintenance requirements. Several conservatisms are built into this number. Recent

plant design changes should result in an improvement of this number.

e. CRBRP's incorporation of known, and in some cases anticipated, NRC requirements into the plant design should produce improved regulatory stability and minimize backfit requirements on the plant.

f. The CANDU reactors have demonstrated a capacity of 85.2 percent post-TMI. The Canadians attribute this success to the detailed design attention to availability. CRBRP availability should be comparable to that of the CANDU reactors because the CRBRP program for achieving high availability is consistent with the essential elements of the Canadian CANDU Program. CANDU reactors have achieved availability factors and capacity factors that equal or exceed the CRBRP goals. Consequently, the CRBRP availability and capacity factor goals are considered realistic and achievable.

g. Regulatory-induced impacts on CRBRP are expected to be minimal due to the fact that all post-TMI fixes have been incorporated in the design, and many of the ongoing unresolved safety issues, such as station blackout and Anticipated Transients Without Scram (ATWS) have been addressed in the CRBRP design.

Further, an independent systems availability assessment of the entire plant is being conducted by System Development Corporation, and Daniel, Mann, Johnson & Mendenhall (SDC/DMJM), to verify that the systems will function as intended and that the design basis availability and capacity are met.

SHAKEDOWN PERIOD CAPACITY FACTOR

20% - First 7 months of operation

36% - Following 6 months

40% - Following 12 months

55% - Following 12 months

75% - Thereafter

For purposes of a conservative revenue projection, a capacity factor of 65 percent has been assumed while sensitivity of the capacity factor will be identified by also calculating revenues assuming a 75 percent capacity factor following the shakedown period.

2. CRBRP Availability

An overall plant availability goal of 82 percent and capacity factor goal of 75 percent were established in the original requirements for CRBRP. Initial emphasis was placed on refueling time as the most fixed contributor of scheduled plant unavailability. The original requirement for refueling time was established at 20 days per year (5.5 percent unavailability) as compared to 37 days greater than 10 percent unavailability for refueling of LWRs).

3. Design To Meet Availability Goal

3.1 Design Discipline

The system design descriptions include operations and maintenance aspects of each system down to mean-time-to-repair and the required plant status for repair of each individual component. The majority of specifications for component design and fabrication contains requirements for each component's reliability and availability, including vendor proof of component reliability through testing or analysis.

3.2 Modeling

CRBRP has made extensive use of modeling and mockups. The emphasis placed on modeling during the plant design to improve operations and maintenance characteristics of CRBRP should favorably affect the plant construction costs and plant availability.

Full-scale mockups of specific areas of the plant, such as the main control panel, reactor upper internals, and head access area (refueling area above the reactor vessel) have been constructed for fabrication, maintenance, and operations reviews. In addition, functional and proof testing of the reactor vessel closure head, through which the nuclear fuel is loaded and unloaded, has been performed to ensure high availability during refueling and to demonstrate short refueling times.

3.3 Design Features For Availability

Important design features/considerations utilized in the CRBRP design to enhance plant availability/capacity factor are listed below:

a. Design and development of fuels to accommodate 2-year refueling interval initially and 3-year refueling interval after the demonstration period.

b. Component design temperatures and pressures that are conservatively selected with respect to operating conditions. The lower operating pressures of 200 psi for CRBRP relative to those for LWR plants (1500-2200 psi) allow use of simplified sealing systems to enhance availability. LWR sealing systems represent a significant maintenance/repair problem.

c. Key plant components, e.g., control rods, pump seals, blanket assemblies, are designed to be readily replaceable during refueling outages to support plant availability goals.

d. A steam generator design that includes features to enhance the reliability of the unit, including:

   --the use of a welded versus bolted steam head design to eliminate seal leakage problems; and

   --the use of a sensitive leak detection system to alert the operators to small leaks to minimize the potential for a large sodium-water reaction and the associated significant repair and clean-up efforts.

e. A heavily compartmentalized plant design to ensure structural separation between components of redundant fluid systems, thus enhancing availability by limiting the damage from a single component failure to a single fluid process loop.

f. The use of an in-vessel fuel handling machine that is removed from the reactor vessel after refueling is completed. This permits complete checkout and functional testing of the machine prior to refueling shutdown and increases the chances for completion of the outage on schedule.

g. The capability of operating on two of three loops has been designed into CRBRP. This will allow continued operation with maintenance on the shutdown loop.

TEC considers these design features to represent a significant commitment on the part of CRBRP designers to ensure that plant availability is maximized.

3.4 Verification

CRBRP is unique among nuclear powerplants in its front-end concern for systems engineering with specific emphasis on reliability, availability, and maintainability (RAM). A

detailed RAM program has been under way at CRBRP for several years and has the following features:

a. An allocation of availability to each system in the plant has been made and viewed as a design target;

b. Assessments of system hardware availability have been made by Westinghouse for Nuclear Island and by Holmes and Narver for Balance of Plant. An independent SDC/DMJM assessment for the total plant is ongoing;

c. A detailed independent systems analysis of CRBRP is in the early stages of completion (conducted by SDC/DMJM); and

d. An independently performed probabilistic risk assessment is providing availability analyses of select (e.g., safety) systems (Phase I--completed) and common-cause effects (Phase II--underway).

The initial balance of plant availability study (Holmes and Narver) concluded that CRBRP availability would most resemble PWR availability. Its assessment indicated an availability of 95 percent for the Balance of Plant and allocated availability targets for each Balance of Plant system.

The Westinghouse analysis of the Nuclear Island in April 1981 assessed availability for all but Balance of Plant systems resulting in an overall plant availability of 0.78. The unavailability drivers leading to the 78 percent Nuclear Island assessment were identified and five design changes were identified to raise the Nuclear Island availability to 85 percent, yielding a combined overall plant assessment of 82 percent.

As part of the design verification program, the ongoing Systems Interactive Analysis, SDC/DMJM, includes the following tasks:

a. Provide an independent assessment of all plant system availabilities;

b. Standardize and update a CRBRP RAM data base;

c. Identify specific areas where availability enhancement can be reasonably expected;

d. Reassess the system-wide availability allocation and change where appropriate;

e. Formally document availability allocation and change where appropriate;

f. Formally document availability improvements; and

g. Develop a plant functional analysis that will model each system and all system interactions.

This entire independent CRBRP systems design assessment effort will be complete in CY 1983.

3.5 Testing

Construction of prototypes was undertaken for those major components where proof-of-design and comprehensive testing were crucial to the demonstration of safety and reliability. Prototype development also provides a demonstration of constructibility.

A program of testing has been developed for all safety-related components for CRBRP. Tests were designed not only for proof-of-design and operability, but also for maintainability and demonstration of selected plant procedures where appropriate. Test results have already led to several improvements in design and operating procedures that will directly increase component reliability and maintainability for plant operation. Notable test program applications include:

a. A full-scale prototype test of the CRBRP steam generator;

b. A full-scale prototype test sodium pump and pump drive/control system;

c. A prototype test of the 200-400 gpm electromagnetic pumps;

d. Mechanical life cycle testing of liquid metal valves under prototypic and seismic loading conditions;

e. Life cycle and seismic testing of prototypes of the Primary Control Rod System;

f. Life cycle and seismic testing of prototypes of the Secondary Control Rod System;

g. Reliability testing of the Plant Protection System (PPS); and

h. Extensive tests of CRBRP Fuel and Blanket Assemblies at CRBRP Conditions.

4. Operating Experience Comparison

The following table provides a comparison of the CRBRP availability goal to that of other reactors and also illustrates the impact of refueling time variations. Of particular note is the Phenix LMFBR, achieving a plant availability of 80 percent for the 2 years following the first 4 years of operation.

COMPARISON OF PLANT AVAILABILITIES

Plants	Availability (Capacity Factor)	Refueling Unavailability
CRBRP (Goal)	82% (75%)	5.5%
CANDU (8 units)	(79%)	0%
PHENIX LMFBR 5/78 - 3/80	80% (80%)	15.6% (Scheduled Outages)
EBR-II LMFBR 1974 - 1981	74%	14%
MATURE U.S. LWR (Greater than 4 years old) 1977 - 1979 (Median)	80%	10.7% 15.5%
MATURE U.S. LWR (Greater than 1 year old) through 1976 (Median)	72% (60%)	10.7% 15.5%

In comparing CRBRP's availability goal to CANDU operating experience, an availability similar to CRBRP's goal has been attained in practice. For the post-TMI period, CANDU's plants have averaged 85.2 percent capacity factor, much higher than U.S. LWR averages. The eight CANDU plants have averaged a 79 percent capacity factor after 4 to 11 years in service. The Canadians attribute reaching these capacity factors more to the detailed design reviews for availability that they conducted than to the on-line refueling capability of their reactor. CANDU designers are given specific

reliability and maintenance target goals at the preliminary engineering phase. Significant attention is given to availability from design through operation. The design review methodology that the Canadians use includes availability aspects similar to the availability program being used at CRBRP.

Notable exceptions to the U.S. LWR average capacity factors are the Point Beach PWRs of Wisconsin Electric Power. Point Beach Units 1 and 2 have gross capacity factors of 78.0 percent to 70.1 percent, respectively, since initial operation in 1970 and 1972. Wisconsin Electric attributes much of this success to a competent staff in plant construction commissioning and operation, and the Point Beach units were designed with maintenance in mind. This has also been the case with the CRBRP.

II. CRBRP Power Generation Capability and Useful Life

The initial operational level of the CRBRP will be at a maximum of 375 Mw or 85 percent of the design gross capacity of 430 Mw. During this initial operating period at 375 Mw gross, the net power available for sale will be 330 Mw. This determination is based on a detailed auxiliary or hotel load study which resulted in an upper limit of 45 Mw auxiliary load for operation at the 375 Mw level. After extended operation at 375 Mw(e) gross, the plant power level will be raised to the level of 430 Mw. The total gross CRBRP power level of 430 Mw is assumed to be achieved in year 10 of operation and thereafter for the 30-year design life of the plant.

The net power available to sell during operation at full design power will be 380 Mw, with an auxiliary load of 50 Mw. This 15 percent increase in power above the initial power level will be achieved by maintaining a constant temperature differential across the core and increasing the flow by 15 percent. The steam generators, sodium pumps, pump drive motors, intermediate heat exchanger (IHX), condensate pumps, feedwater pumps, turbine generator, and the electrical system including the main transformers, buses and transmission lines have sufficient margin for the 430 Mw(e) gross power level.

The Clinch River Breeder Reactor is designed to have a 30-year life. This lifetime is based upon an 82 percent availability factor and a 75 percent capacity factor for the lifetime of the plant with the exception of the first 3 years. Any decrease in availability and load factor would result in an increase in a number of calendar years of lifetime of the reactor.

The CRBRP design life for structures, systems, and components is based on judicious selection of materials, protective finishes, and/or protective practices chosen to satisfy the 30-year design life by means of preventive maintenance or redundancy to assure that, (1) the design life is achieved and (2) that plant availability is not affected.

The life of all primary and intermediate heat transport system components is based upon a very conservatively determined design duty cycle that postulates a very large number of anticipated, upset, and emergency events in addition to a high temperature steady-state hold. Since both the number and magnitude of the transients are extremely conservative, in all likelihood, the lifetime of this plant could be extended even beyond 30 years. The basic plant is designed using austenitic stainless steels which are less susceptible to radiation damage and other material problems characteristic of light water reactors which largely use ferritic steels.

Those components that cannot achieve 30 years without degradation, such as the seals in the pumps are designed to be easily replaceable and have a replacement schedule during regular maintenance periods.

In summary, a very conservative analysis is used to assure that the lifetime of the plant is at least 30 years. In all likelihood one could find it stretching well beyond 30 years. EBR-II experience indicates that the lifetime of a liquid metal plant is significantly beyond the design lifetime based on detailed examination (in-service inspection) of equipment after 20 years of service.

APPENDIX D

CRBRP Revenue Projections

Previous projections of the revenues derived from CRBRP electricity production have been based on the current contract with TVA to purchase CRBRP electricity at TVA's avoided cost.* The TVA/CRBRP contract identifies the last 100 MWe of TVA generated electricity as the basis for estimating TVA's avoided cost. TVA's forecast of this cost implies that electricity from existing coal plants will be displaced during the project demonstration period of FY 1991-FY 1995.

Electricity may logically be sold at an avoided energy cost that recovers only marginal operating costs with no amortization of capital if the power is being supplied on a nonfirm, interruptable basis. For the purposes of this study, however, it is clear that private investors would intend to sell power on a firm basis, operating the plant as a baseload station as it has been designed.

A survey of 25 utilities in the southeastern United States indicated that as of FY 1993 and thereafter, new baseload capacity would be required by a majority of the utilities surveyed in order to maintain a reserve capacity of 20 percent.(1) In addition, analysis of data provided by the Southeastern Electric Reliability Council (SERC) and the Oak Ridge National Laboratory (ORNL) confirms the need for new baseload capacity in the southeastern United States before FY 1995.

The SERC includes Tennessee, the Carolinas, Alabama, Georgia, Florida and portions of Virginia, Kentucky and Mississippi. Except for Florida, all SERC utilities are within an efficient transmission distance of CRBRP. Today, SERC has much more power than it needs to serve electric demand reliably. Also, SERC anticipates enough new capacity to serve projected demand through 1995.(2) However, SERC's plans for 1990 (as of 12/31/81) include three coal units which are not yet under construction and three nuclear units whose construction is less than one-tenth complete. There are seven coal units that are planned for Florida which have not been accounted for since Florida is outside the assumed transmission range of CRBRP. If these plants are included,

*In the Public Utility Regulatory Policies Act of 1978, avoided cost is defined as "the incremental costs to an electric utility of electric energy or capacity or both, which, but for the purchase from the qualifying facility or qualifying facilities would generate itself or purchase from another source."

SERC's plans include ten coal units not yet under construction and three nuclear units whose construction is less than one-tenth complete. One of these nuclear plants (North Anna 3) has been subsequently cancelled.

Therefore, SERC's planned capacity of 153,320 MWe in 1990 is, in actuality, only 149,113 MWe of committed capacity beyond 1990.[3] Unless SERC actually constructs the planned but not committed capacity, SERC's projected peak demand in 1995 would only be served by a 5 percent reserve margin. In order to serve SERC's projected 1995 peak demand of 141,841 MWe with a 20 percent reserve margin, approximately 16,000 MWe of additional capacity (excluding Florida) will be required. CRBRP power (provided on a firm contract commitment) would only displace 2 percent of these projected 1995 capacity requirements.

It is well recognized that electricity demand forecasts have been revised downward over the last several years. It is also recognized that econometric models are not capable of predicting the underlying structural changes in the use of electricity. These changes, such as improved end-use efficiency, are largely responsible for the need to reevaluate electricity demand forecasts. In order to evaluate the impact of these factors on the required incremental baseload capacity in the CRBRP market area, the Oak Ridge National Laboratory has provided an assessment of power needs in this service area[4]. Two models were employed by ORNL. One model was econometric, while the other model was an integrated end use model. The latter model is explicitly sensitive to the structural changes which have resulted in lower electric power demand forecasts.

The models provided forecasts for a geographic area roughly equivalent to the SERC market area. Four sets of input assumptions were used. These input assumptions correspond to low, medium, and high world oil price cases and to a Southern Regional Growth Case. See reference 4 for details. The range of forecasted peak electricity demand for the SERC market area in 1995 was 143,000-153,000 MWe from the structural end use model and 194,000-203,000 MWe from the econometric model (see Table D-1). The lowest forecast (143,000 MWe) is slightly higher than the recent SERC forecast discussed above (141,841 MWe (see reference (2)). Therefore, our independent analysis of the need for power indicates that at least 17,000 MWe of additional capacity will be required to serve SERC in 1995 with a 20 percent reserve capacity (excluding Florida). If the highest forecast from the structural end use model were used, 27,000 MWe of capacity would be required by 1995. The econometric model forecasts imply much higher required capacities.

The survey of utilities indicated that new coal-fired baseload units are the appropriate alternatives displaced by firm power

supply contracts. Several studies indicated that the most economical increment of this type of capacity is represented by twin 600 MWe coal-fired plants (5, 6). If the revenue requirements of such a plant were used to negotiate CRBRP contracts, utilities would have the advantage and opportunity of purchasing smaller increments of baseload capacity (30 to 330 MWe) at the same cost per MWe as provided by a 1,200 MWe plant. This provides a substantial benefit to utilities since they may avoid construction of less economic units, underutilization of larger units, joint development of larger plants with other utilities, or periods of inadequate reserve capacity. This economic advantage is particularly beneficial to smaller utilities, e.g., municipal utilities.

The revenue requirements of a two-unit coal station (each unit = 600 MWe) were developed for the region by ORNL (6). The capital cost for this plant (scheduled for commercial operation in 1991) is estimated at $1,250/MWe (1984 $). If this plant investment is prorated to a smaller 330 MWe plant (equivalent to CRBRP), the plant investment at 1991 commercial operation would be $412.5 million (1984 $). This capital cost estimate was used to develop the revenue requirements of a baseload plant displaced by CRBRP. A single coal-fired 350 MWe plant would require a $584 million investment.[7] Two avoided cost estimates were developed using different coal price projections derived from the 1981 Annual Report to Congress by the U.S. DOE.[8] The low coal price forecast assumes no real rate of inflation in the price of coal while the high coal price forecast assumes a 2 percent annual real rate of inflation. The low coal price forecast results in a revenue requirement of $97/MWhr (1984 $) in FY 1991 while the high coal price forecast increased the revenue requirement to $104/MWhr. These data are displayed in Tables D-2 and D-3 as Case 1 (low coal cost) and Case 2 (high coal cost). CRBRP is estimated to achieve a capacity factor of 75 percent after the initial shakedown period (see Appendix C). However, in order to provide a conservative estimate of future revenues, a 65 percent capacity factor was used instead.

TABLE D-1

1995 Forecasted Peak Electricity Demand
for SERC Market Area (MWe)

Case	Structural Use Model	Econometric Model	Currently Planned** Firm Capacity	Required New Capacity Implied by Structural End Use Model*	Required New Capaci Implied by Econometri Model*
Low World Oil Price	142,936	194,099	149,113	17,480	65,369
Medium World Oil Price	147,227	194,435	149,113	21,496	65,683
High World Oil Price	149,775	194,581	149,113	23,881	65,820
Southern Regional Growth Case	153,009	203,233	149,113	26,908	73,918

Source: Oak Ridge National Laboratory, "Initial Phase Draft Report, Clinch River Breeder Reactor, Assessment of Need for Power and Service Area," February 28, 1983, Letter from D.M. Hamblin to D.C. Keeton, dated March 2, 1983, and North America Reliability Councils Electric Power Supply and Demand (1982-1991), August 1982.

*Required to maintain a reserve capacity of 20 percent, Florida excluded.
**Assumes currently planned capacity in Florida is firm. All currently planned capacity (except Florida) that is not yet under construction or is less than 10 percent complete (nuclear only) is assumed not to be firm capacity.

TABLE D-2

AVOIDED COST

CRBRP Electricity Price Projections

	FY 1991 Electricity Price (1984 $/MWhr)
Avoided Energy and Capacity Cost (Baseload Capacity Displaced)	
1 (Low Coal Cost):	$ 97
2 (High Coal Cost):	$104

TABLE D-3

CRBRP Electricity Price Projections
(Year of Expenditure $/MWhr)

	Case*	
Fiscal Year	1	2
1991	146	157
1995	151	173
2000	165	206
2005	189	261
2015	292	488
2020	374	690

*See Table D-2 for case definitions

NOTES

1. S. M. Stoller Corp., Projections of Revenues from CRBRP Operation, March 8, 1983.

2. North American Reliability Council, Electric Power Supply and Demand (1982-1991), August 1982.

3. The estimate of 149,113 MWe of committed capacity does not account for the planned coal plants in Florida (outside of CRBRP market area) and therefore assumes that these plants are constructed. If all of the planned powerplants in SERC are subtracted from SERC's estimate of 1990 capacity, only 144,998 MWe is committed capacity

4. Oak Ridge National Laboratory, "Initial Phase Draft Report, Clinch River Breeder Reactor: Assessment of Need for Power and Service Area," February 28, 1983.

5. U.S. Department of Energy, Energy Information Administration, Projected Costs of Electricity from Nuclear and Coal-Fired Power Plants, DOE/EA-0356, August 1982.

6. U.S. Department of Energy, Nuclear Cost Data Base, A Reference Data Base for Nuclear and Coal-Fired Power Plant Power Generation Cost Analysis, DOE/NE-0044, October 1982.

7. J. G. Delene, G. R. Sanders, H. I. Bowers, Engineering Economic Analysis of Utility Alternatives to the Clinch River Breeder Reactor, Oak Ridge National Laboratory, March 1, 1983.

8. U.S. Department of Energy, Energy Information Administration, 1981 Annual Report to Congress, February 1982.

BREEDER REACTOR CORPORATION
P.O. BOX 767, CHICAGO, ILLINOIS 60690

March 12, 1983

Mr. Wallace B. Behnke
Chairman
Project Management Corporation
Post Office Box 767
Chicago, IL 60690

Hon. Donald Paul Hodel
The Secretary of Energy
Department of Energy
Forrestal Building
1000 Independence Avenue, SW
Washington, DC 20585

Gentlemen:

As you know, Breeder Reactor Corporation, as part of its responsibility to provide senior counsel to the Clinch River Breeder Reactor Project ("CRBRP"), has assembled a task force to explore possible alternative financing possibilities for supplementing future Federal appropriations supporting the construction and operation of the Project.

Within the few weeks available, the task force considered future financing options based on possible values of the plant, its revenues, the values of possible tax credits, and other values. A report on the results of the consideration of these issues by the task force to date is enclosed for your information and use.

In forwarding the task force report along with a number of my personal observations, I would like to point out the preliminary nature of the studies undertaken by the task force and the absence of that type of detailed review at this stage that would normally be attendant to such transmittals. Because of a desire to provide information in a useful form in a brief period of time, the task force has had limited opportunity to exchange comments and ideas with others. The task force report has not yet been reviewed by the BRC Board of Directors or the organizations they represent, but is being transmitted to the Board herewith.

The task force recognizes that there are many risks and uncertainties involved in determining the market value of a first-of-a-kind demonstration project such as the CRBRP at this stage of its development. They relate to licensing, plant completion, testing and operation, the potential market for the plant's electricity, competition for funds and other government resources and other issues. The task force is well aware that additional guidance from the utility industry, the nuclear equipment industry, the financial community, and government will be required to permit the exploration in more detail of the potential impact of such considerations on possible financing options.

There are a number of ways in which financial assistance could be provided. However, experience with each of these options on other projects suggests that further meaningful development of the most promising options for this Project depends on the government's role and its commitment for the long term to the CRBRP and to the nuclear power policies and programs tightly interwoven with this Project.

The BRC Board of Directors has frequently reaffirmed its position that the CRBRP is a unique project of great national value, warranting continued industry support and DOE's highest priority for available Federal funding and other support. Among its responsibilities to this Project, DOE has an obligation under current Project arrangements to continue to seek sufficient Federal funding to see the Project through to completion. As the task force report points out, access to private financial markets for supplemental funds will require a complex of government commitments and assurances.

Much of the criticism and debate concerning the CRBRP is now structured around the financial consequences of the delays which have plagued the Project. These delays are largely the result of changing and conflicting Federal policies and plans and organizational and financial decisions, along with the extraordinary inflationary pressures which affected the economy for several years. These are matters over which the utility and industrial participants in the Project have had no control.

The Project's managers and the industrial base have performed remarkably well in areas within their control, despite extended delays in licensing and construction, the Project's first-of-a-kind development characteristics, and the impact of the Three Mile Island accident on new licensing requirements by the NRC. Project design is almost 90% complete.

Major components, both completed or on order, total $740 million, representing about 75% of the major nuclear components. Site preparation work is well underway. More than $1.5 billion has already been invested in the Project.

I understand that more than 3,500 government and contractor employees throughout the United States are currently working on the Project, including highly skilled scientists and engineers, factory workers, and construction trades personnel, and that the Project includes a significant commitment to minority contracting and minority employment. Moreover, because of its advanced stage of design, proceeding to full-scale construction will permit the employment of several thousand additional personnel.

The task remaining is to complete the design and construct and operate the plant to demonstrate the practical characteristics of breeder technology.

BRC is convinced that demonstration of the Liquid Metal Fast Breeder Reactor (LMFBR) technology is essential to its continued development. The CRBRP has evolved from costly, but productive, engineering investments by both government and industry since the 1950's. The national LMFBR research and development program has confirmed the technical and engineering feasibility of the LMFBR concept and the CRBRP. A well-documented technological base has been reinforced by a well structured, experienced industrial base building on the government's scientific and laboratory resources and the guidance of the nation's utilities. Operation of the Experimental Breeder Reactor II, the successful start-up and full-power operation of the Fast Flux Test Facility (FFTF), increasing confidence in nuclear fuel performance and knowledge of key technology-related safety and licensing matters have contributed to increased engineering confidence and have helped reduce the R&D and first-of-a-kind risks in the CRBRP design. Nevertheless, uncertainties remain.

Further progress in the LMFBR program requires, first, maintenance of industry confidence that the CRBRP can be completed and successfully operated. Primary attention can then be directed to arrangements for the design and construction of a utility-sized demonstration plant. Information gathered from the FFTF and the CRBRP will not only be essential to the design of a larger plant, but will also

enhance the ability of the U.S. to enter into meaningful international collaboration for further development of the LMFBR.

The overall LMFBR program, and the role and responsibilities of government and industry within that program, are patterned after the successful experience with Shippingport, Dresden, Yankee and other major nuclear projects in the AEC's Power Reactor Demonstration Program. DOE publications show estimated government expenditures for Light Water Reactor (LWR) plant research and development and fuel cycle support at about $5 billion. I understand that at this stage the private sector has invested well over $150 billion and committed billions more to carry this LWR technology from the demonstration plant phase into the commercial introduction and deployment phases. Over the past ten years, consumers have saved about $25 billion because the LWR option has been available to the nation's electric utilities.

The nation is on the right track in building up and integrating a technological, engineering, industrial, and construction force infrastructure and demonstrating its practicality in careful steps before proceeding to commercial introduction of the LMFBR concept. In addition to the $1.5 billion already invested in the CRBR Project, countless other investments in dollars, time, facilities, and technology in the industry and in the base R&D program would be placed in jeopardy or lost, if a decision were made to further delay or cancel the CRBRP at this stage. If a decision were made to continue to carry out a strong breeder program without the CRBRP, the cost to the nation would certainly be much greater than presently required. No better nor more economically realistic alternative has been proposed and supported in a meaningful manner.

For more than thirty years, every President, every Congress, and the industrial and scientific community have supported the premise that this nation must have viable domestic energy options to support our economy, our security, and our ability to maintain effective domestic and foreign policies. Events within the past ten years, here and abroad, provide ample justification to move forward with a sense of urgency to achieve these objectives. Studies of viable domestic alternatives have confirmed that nuclear power must continue to play a major role in achieving these national goals. One of the most critical elements of the nuclear option is the government's long-standing commitment to the expeditious

development and demonstration of the LMFBR to permit the private sector to make market decisions regarding its future commercial development.

The following points, which have emerged from a review of assessments of our domestic energy options by government, industrial, and scientific bodies, impress me as vital in the context of our nation's nuclear power program:

> At this stage, a decision not to sustain a strong national breeder program would imply the phasing out of nuclear fission as a domestic energy source.
>
> If the future role of nuclear power is viewed as uncertain, but a nuclear option is to be maintained, constructing and operating a breeder demonstration plant is necessary.
>
> Such a demonstration plant is an integral and key element of the breeder research and development program; no commitment to build commercial breeder plants could possibly be considered or made unless and until the construction and operation of such a demonstration plant have been evaluated.
>
> The CRBRP is the only technically acceptable, economical, and timely demonstration plant available.

America must retain and develop all of its few promising long-term energy sources, including breeder reactors. Events during the past decade of turbulence in energy supplies have confirmed the wisdom of the decisions which led to planning for the CRBRP and have reinforced the need for its aggressive completion. The Project warrants the highest priority for continued support by government and industry.

National security, industrial strength, and economic well-being all require adequate and reliable supplies of electrical power at reasonable rates. Long-term projections for economic recovery dictate that the nation must have demonstrated electric energy supply options to support long-term growth. At present, only coal and nuclear fuel can be relied upon to fulfill these bulk power needs in the foreseeable future.

Congress has committed a substantial sum, over $18 billion, and authorized the formation of special government-

industry institutional arrangements in an important effort to stimulate the development and demonstration of domestic synthetic fuels technologies by the private sector. While a smaller financial commitment will be required for the breeder, a comparable national commitment to further development and demonstration of the LMFBR technology is essential.

I hope that the task force submittal along with my comments will help encourage constructive attention to the completion of the CRBRP and to the serious national energy R&D issues which are focused on the Project.

Sincerely yours,

James J. O'Connor
Chairman

cc: BRC Board of Directors

EXPLORATION OF ALTERNATIVE FINANCING POSSIBILITIES FOR THE CLINCH RIVER BREEDER REACTOR PROJECT

A task force report to the Breeder Reactor Corporation on alternative financing possibilities for the CRBR Project.

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March 12, 1983

HIGHLIGHTS OF THE BRC TASK FORCE REPORT

- The CRBR Project can attract significant new-source capital funds, perhaps as much as forty percent of the $2.4 billion remaining cost to complete.

- Some of this can be provided by capitalizing on the value of the Project through firm contracts for its power output, supported by appropriate Federal assurances.

- The amount of private investment will be enhanced by assuring the availability of conventional Project-related tax incentives.

- Sufficient and timely funding must be provided to maintain optimum construction schedules; vigorous efforts must be continued to prevent slippages and unnecessary cost increases. This will require prompt action by Congress, DOE and the private sector.

- Further schedule delays cannot be tolerated because of their effect on costs.

- Legislation will be needed to assure timely Federal support and to amend the existing Project authorization so as to permit requisite Federal assurances with respect to completion, licensing and operability of the Project.

- One way to facilitate private financing would be to create a new entity, possibly a joint-venture, with a Federal corporation or agency as general partner and private investors as limited partners. The financing framework would be similar to that used for any large construction partnership in that tax benefits could be allocated among the partners.

- No single approach or set of alternatives is recommended. The Task Force stands ready to assist in determining how best to proceed.

March 12, 1983

REPORT OF THE CLINCH RIVER BREEDER REACTOR PROJECT TASK FORCE

Overview

This report describes a number of possibilities for minimizing Federal budget requirements for the Clinch River Breeder Reactor (CRBR) Project and securing greater participation from private investors. It concludes that significant new-source funding can be secured for the Project if Federal efforts are clearly centered on the twin goals of completing the Project promptly and providing the kinds of firm assurances and tax benefits which private investors generally require for a project of this magnitude.

General Background

On December 3, 1982, at a meeting of the Breeder Reactor Corporation (BRC) Board of Directors, James J. O'Connor, Chairman of the Board, authorized the assembly of a Task Force to make an objective examination of alternative financing possibilities for the CRBR Project. The Task Force includes representatives of the electric utility industry and investment banking community with legal and technical advisors. Its formation, which is based upon BRC's responsibility to provide "senior counsel to [Project Management Corporation] PMC in the interests of the Project" (BRC/PMC Agreement, Article XIV(c)), was in response to Congressional concern about the level of future Federal budget appropriations for the Project as expressed in a Senate Appropriations Committee report. Later in December, Congressional Conferees approving fiscal year 1983 funding for the Project required the U.S. Department of Energy "... to vigorously explore proposals including a reconsideration of the original cost-sharing arrangement, that would reduce Federal budget requirements for the Clinch River Project or project alternative, and secure greater participation from the private sector." (H.R. Rep. No. 97-980 at 186, 97th Cong., 2d Sess., 12/20/82.) The DOE was directed to submit its findings to the cognizant Congressional committees not later than March 15, 1983.

In view of the action of the Conferees, the Task Force is submitting the following report, exploring possible Project financing proposals, to BRC.

The membership of the BRC Task Force was established in January, 1983. Its first meeting was held late that month. In carrying out its task, the Task Force consulted with outside financial and banking experts, some corporations involved in the Project, and the DOE. The limited time available prior to March 15 has necessitated a broad definition of alternative proposals rather than detailed specification of precise institutional vehicles, statutory changes and contractual terms that must ultimately be developed when the DOE, the private sector and the cognizant Congressional committees determine the preferable course to follow in order to assure, to the extent possible, the continued progress of the CRBR Project towards final design, construction and operation.

Several guiding principles underlie the Task Force's approach to the issues presented by alternative financing proposals. These include the following:

- The CRBR is essentially a national research and development effort and an important part of the National Liquid Metal Fast Breeder Reactor (LMFBR) program.

- The CRBR Project can result in an electric generating facility with significant marketable value and output. However, there are far too many uncertainties relating to its licensing, construction, completion, and operation to be financed independent of Federal financial aid and legislative and administrative support.

- The CRBR Project, if successful, will not be available for the sale of power until 1990. Projections of costs and revenues at that point and for up to 30 years thereafter are necessarily speculative and uncertain. Thus, the estimates presented in this report (based on information provided by DOE) should serve only as a general guide for the purpose of estimating future financing requirements.

- The existing Project arrangements were worked out with great care and have established rights and obligations which should not be disregarded in assessing alternative proposals. Such proposals should complement the present contract arrangements to the extent possible.

- The Task Force has not offered political assessments of alternative proposals, but has

assumed favorable legislative action to support reasonable financial alternatives designed to "reduce Federal budget requirements."

Risks, implications and uncertainties involved in determining the ultimate degree of reliability of this first-of-a-kind developmental project and the market value of its output have not been dealt with exhaustively. These uncertainties include those relating to licensing, back-fitting, completion, testing and operation; the R & D role of the Project; the potential market for its electrical output; and the need to compete for Federal funds and other Government resources. A great deal of additional guidance from the electric utility industry, the nuclear equipment industry, the financial community and the Federal Government will be required to estimate the future commercial value of the Project with the degree of certainty needed to determine precisely how much capital can be raised from private investors.

The detailed findings of the Task Force are set forth in the following sections.

I. Cost to Complete

Under the May 4, 1976 Project Agreement, the DOE is obligated to use its best efforts to obtain from Congress whatever additional funds are needed to complete the Project and demonstrate the technology.

The Task Force was asked by BRC to explore alternative sources of Project financing and to advise BRC whether such alternative sources, when coupled with continuing Federal appropriations at roughly present levels, will be adequate to complete the Project. The Task Force did not make an in-depth examination of the Project schedule and costs, but was provided with DOE's latest construction schedule and cost estimates which indicate that the CRBR Project can be completed by October 1989 at an estimated remaining expenditure of $2.4 billion after FY 1983. These estimates assume that the construction schedule is not constrained by further funding limitations. Thus, the completion date and remaining expenditures are highly dependent upon resolution of existing funding uncertainties. If the construction schedule were to slip, the estimated remaining cost to complete the Project could increase significantly.

For purposes of this report, the Task Force accepted DOE's estimate of $2.4 billion to complete the Project, assuming that further delays will be avoided; and recognizing that this assumption (and, hence, the cost estimate itself)

depends upon prompt actions relating to the resolution of Project funding.

The deleterious effect of delays. It is enormously costly to delay or stretch out any large construction project, particularly a large R & D project, such as the CRBR Project, due to additional carrying charges during the delay period, escalation of construction costs, and added expenditures associated with using less than optimal construction forces. Members of the Task Force have had direct experience with such delays and, accordingly, all of the projections in this report assume prompt Federal action, including timely future funding by the Congress, so as to permit optimal work scheduling from this point on. Absent these, the conclusions of this report cannot be supported.

II. New-Source Funding Needs

Future contributions from the electric utility industry, already committed, will provide $172 million, and other contributors will provide $5 million, for total future contributions of $177 million. While part of these contributions are scheduled to be made after FY 1991, it is assumed that all such amounts can be made available for funding Project construction plus interim financing costs, to the extent they must be paid currently.

Assuming minimum future Federal funding at roughly current levels for a total of $1.4 billion subsequent to FY 1983, the additional amount required to be provided from new sources, in order to fund total Project costs, would be about $800 million, as shown in the following table:

TABLE I
REMAINING CAPITAL REQUIREMENTS

	Billions
Federal funding	$1.4
Utility contributions and others	0.2
New-source funding required	0.8
Total funds needed	$2.4

Adding a modest allowance of $300 million for those out-of-pocket financing costs which must be paid during the construction period, an estimate of $1.1 billion seems reasonable for the Project's future new-source funding needs, but this amount can vary widely, depending upon the financing plan selected.

III. New-Source Funding Requirements Exceed the Probable Proceeds of a Sale of the Project Itself

The maximum future market value of the CRBR Project, measured in terms of the likely avoided cost of constructing alternative coal-fired units equipped with scrubbers, is not expected to exceed $2,300 per KWe.*

If the 330 MWe conservative net rating of CRBR were priced at $2,300 per KWe, the result would be $750 million. If the 380 MWe design net rating were priced at $2,300/KWe the result would be nearly $900 million. However, the facility is worth less than that today because achievement of a commercial level of reliable operation is at least nine years away. Moreover, steps must be taken to reduce completion risks and the like before Bankable** securities can be sold and full market value realized.

IV. Power Sales Constraints

Studies show a probable need for additional electric generating capacity in the SERC region in the early to

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* Generation in the Southeastern Electric Reliability Council (SERC) Region, outside of Florida, is predominantly coal-fired. The $2,300 figure is derived from a range of estimates available from several sources for base-load coal-fired capacity installed in the SERC region for commercial service in 1992 (the earliest date at which commercially reliable output is expected to be available) -- in short, ten years hence -- and using annual cost escalation rates in the 8% to 9% range.

** The terms, "Bankable" and "Bankable Commitments", as used herein, mean that the contract or obligation in question is sufficiently firm to provide adequate security for a non-recourse loan, advance, leasehold investment, or equity participation.

mid-1990s. However, utilities in that region may be reluctant to assume certain risks associated with long lead-time commitments for CRBR power, namely:

- o projected load growth in the SERC region may not materialize;
- o the level of power revenues needed to pay Project debt service and other financing costs may exceed the purchasers' "Avoided Costs;"* and
- o the Project may not be able to produce the power contracted for.

Regulated electric utilities tend to be inhibited from making risky long-term capacity commitments because the regulatory penalties for over-commitment are severe. In view of the possibility that such penalties might be imposed, regulated utilities in the SERC region may be reluctant to enter into long-term obligations today (i) to purchase minimum annual quantities of CRBR power, or to purchase the Clinch River Project itself (or the Balance of Plant, i.e., the Project excluding the Nuclear Steam Supply System) because anticipated load growth might not materialize; or (ii) to pay a specific minimum price for CRBR power because that price might prove to be in excess of their systems' Avoided Costs.

Nevertheless, the Task Force is confident that, if appropriate arrangements are developed, such reluctance can be overcome. However, the very existence of such reluctance is evidence of the need for the kinds of assurances deemed essential, as discussed below.

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* "Avoided Costs" is a technical term derived from Section 210 of the Public Utility Regulatory Policies Act (PURPA). Section 292.101(b)(6) of the regulations implementing that Act defines "Avoided Costs" as follows:

> "(6) 'Avoided Costs' means the incremental costs to an electric utility of electric energy or capacity or both which, but for the purchase from the . . . qualifying facilities, such utility would generate itself or purchase from another source."

The PURPA regulations generally provide that electric utilities must pay full avoided costs for electricity generated by small power producers and cogenerators.

V. Range of Possible Market Values

The CRBR Project will have significant potential market value when completed and the plant is operating as a base-load electrical power plant. Realization of that value prior to the end of the shakedown period (now scheduled for mid-1992) will depend upon unconditional Federal assurances, as discussed below. Such realization may be accomplished in a variety of ways, as follows:

- o sale of the Project,
- o sale of the Balance of Plant (BOP), accompanied by a viable steam supply contract, and
- o pledge of the future revenue stream.

Sale of the Project. As a practical matter, it would be difficult to sell the entire Project today (or to sell securities approaching its full value) because the accident at Three Mile Island and the controversy surrounding the Washington Public Power Supply System (WPPSS) nuclear program have left investors leery of large nuclear power plant projects, whether or not they are backed by apparently firm governmental assurances. This suggests that the inherent value of the plant itself would have to be supplemented by a long-term power sales agreement backed by an unconditional Federal warranty of minimum revenues.

Setting aside, for the moment, the value of the revenue warranty, it is reasonable to assume that the Project itself may ultimately be worth as much as the coal-fired capacity which would otherwise have to be built. Applying the $2,300 per KWe figure already mentioned to the full 380 MWe net rating of the Project indicates that the maximum capacity value of the Project may, in 1992, approach $900 million. The tax benefits normally associated with plant construction and ownership would provide additional value which, however, cannot be quantified at this time.*

Sale of the BOP. The BOP would have little market value without an assured supply of steam. A contract to supply such steam at an assured price per Kwh would be essential if the BOP were to be sold for a significant amount. A long-term power sales agreement backed by Federal assurances would also

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* There should be no net loss to the Government through the use by CRBR of existing construction-related tax benefits. This is because any such benefits used in connection with the CRBR will displace those that would otherwise have applied to new capacity displaced by CRBR.

be required. The amount for which the BOP could then be sold would depend, of course, upon the terms of those two contracts. Assuming that the steam contract were designed to maximize the value of the BOP, then the BOP might be sold for a significant figure, not because of its replacement value in terms of turbine generator, condenser, switchgear and the like, but because of the value of the future net revenue stream (after deducting steam supply costs), coupled with construction-related tax benefits already referred to.

A simple pledge of the warranted future revenue stream. The value of the future power output of the Project will vary depending upon the amount of assured output and the net revenue per Kwh available to cover debt service and equity return. For example, minimum net revenues of 6¢ per Kwh (after deducting fuel, other operation and maintenance expenses) on an assured annual output of two billion Kwh for 20 years beginning in 1992 would provide $120 million a year, an amount adequate to pay the debt service (and equity return), at an assumed 10% annual cost of money,* on approximately $1 billion invested in 1992 -- $1,020 million. A minimum net price of 6¢ per Kwh does not seem unreasonable for the 1990s and thereafter, in terms of Avoided Cost projections for SERC region utilities which have committed their 1990s capacity needs. However, bus-bar electricity cost projections from new coal-fired units in the SERC region for the 1990s and thereafter are in the 15¢ per Kwh or higher range. If net revenues pegged at this level or modestly lower could be assured through firm DOE contracts, significantly larger amounts could be provided.

It should be emphasized that to be Bankable, the power contracts must be the hell-or-high-water type. In short, they must guarantee the payment of annual dollar amounts adequate to cover financing costs no matter what happens.**

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* The precise interest rate applicable to the financings referred to above and hereinafter would depend upon market conditions when such financings were arranged. In today's market, a 10% annual rate is on the optimistic side. However, other assumptions set forth herein tend to be on the conservative side.

** With moderate economic growth over the long-term, new capacity is expected to be required in the SERC region. Thus, while firm utility contracts to purchase power at displaced capacity rates will be difficult to achieve in the near term, as future capacity needs become clear such contracts may be forthcoming. Thus, while Federal revenue assurances will be needed in the near term, the Government might not have to pay on such assurances unless, of course, the expected economic growth and capacity requirements do not materialize when needed.

In setting forth the foregoing range of 1992 values, the Task Force avoided pinpointing a precise value because it will depend upon the character of the arrangements provided. However, several relevant observations can be made:

(1) It appears that the market value in 1992 (for investment purposes) may be in the range of $1 billion.

(2) If the Project or the BOP is purchased by investors, the investment value can possibly be enhanced through conventional construction-related tax benefits, viz, those associated with amounts invested in newly-constructed depreciable property.

(3) The amount of funds which can be made available to cover actual construction expenditures will vary widely depending upon when the money is actually invested. For example --

- o The proceeds of a $1 billion investment in 1993, if invested in 1983 with no interest or other return payable for ten years, would provide useable funds (in 1983) of only $385 million, assuming 10% annual cost of money.

- o If the funds are invested in 1988, the net amount thus available (again assuming no interest or other return payments until 1993) would be $620 million.

- o Alternatively, if the funds are invested in four equal annual amounts, from 1986 to 1989 inclusive, such investments would amount to $150 million a year for a total of $600 million.

Given the range of possible investment values arising from varying revenue streams, tax considerations and present value discounting, a carefully worked-out plan will be required to thread one's way through the array of opportunities and obstacles confronting the Project financing. The Task Force stands ready to assist in developing acceptable arrangements for capitalizing on the future market value of the CRBR Project in order to obtain significant financial support for the Project.

VI. Suggested Plans to Capitalize on the the Value of the Project

The future market value of the CRBR Project can be capitalized on, if, and only if, the licensing, completion and operating risks are eliminated through prompt Federal action. Also, appropriate fuel supply assurances must be provided and private investors assured that future revenues will be adequate to earn an appropriate return on, and return of, their investment.

As indicated in the foregoing Sections, several approaches seem feasible:

(1) Straight-forward borrowing based upon future power supply contracts.

- The DOE might contract to purchase the entire CRBR output for use in its uranium enrichment plants, with annual payments sufficient (net of operating costs) in any event to pay the debt service. That contract could then be pledged as security for a long-term loan.

- Alternatively, the DOE might warrant that the CRBR will produce a minimum amount of power and provide price supports such as those proposed for synthetic oil in the mid-1970s when the Government offered to provide such oil at a support price for resale to user utilities. There is ample precedent for price support in Public Law 96-294, the Energy Security Act. Such price supports should be adequate to cover all debt service requirements.

(2) Sale of Partnership equity interests and debt securities of an entity which would purchase and own the entire CRBR Project.

- To be marketable, such Partnership equity interests would require broad Federal assurances as to the deliverability of a reliable and acceptable facility.

- Long-term power sales contracts (like those described under (1)) would also be required.

- o In order to realize the full extent of available tax benefits, favorable IRS rulings would be essential.

(3) Sale of Partnership equity interests and debt securities of an entity which would purchase and own only the BOP.

- o This approach would require all those items discussed under item (2) except that BOP operating risks might be assumed by the owners.
- o In addition, an acceptable steam supply contract would be required because, without such a contract, commercial viability cannot be assured.
- o With appropriate contractual provisions, this approach may be the best way to maximize the tax benefits associated with the Project.

Conclusion. Under any of the foregoing plans, it would be feasible to work out arrangements so that payments received for the future value of the Project or the BOP would be adequate to provide significant investment support.

VII. Other Approaches to Funding Capital Requirements

The only other way to obtain significant additional capital funds from private investors would be to provide other assets or potential benefits adequate to assure that the investor will get something of value in return and be compensated for risk.

Potential "assets" not already discussed fall into six categories:

(1) Assurances that private investors will recover their investment and the cost thereof if timely Federal appropriations are not provided, and that annual appropriations will be continued if the Project is delayed.

- o Such a commitment would assure investors that the Federal Government intends to see the Project through to completion despite past uncertainties.

- o It would also facilitate interim financing during periods of peak construction expenditures.

(2) Additional tax incentives, similar to those associated with any large capital-intensive R & D project.

- o Such tax incentives would not be a wind-fall for investors; instead, they would be designed to provide additional "value" which the Project can offer in exchange for funds invested. For full discussion, see the appendix prepared for the Task Force by tax counsel.

(3) Other source of funds.

- o Possibilities include additional warranties by manufacturer/vendors and architect/engineers and additional R&D commitments from manufacturer/vendors and architect/engineers, or the domestic electric utility industry. Local regulation and the controversial nature of the CRBR Project would make it very difficult to raise such funds from either the regulated electric utility industry or the Electric Power Research Institute. Any attempt to do so might well jeopardize existing CRBR funding arrangements.

(4) Additional foreign R & D commitments.

(5) Licensing revenues, based upon potential patent rights.

- o Action would be needed to protect breeder R & D from reaching the public domain and make potential worldwide licensing revenues available to support CRBR Project financing.*

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* Care would have to be taken to assure that such action did not diminish the patent rights of the BRC members under their Utility Contribution Agreements, which could jeopardize collections from such members.

(6) Direct Federal assurances.

- o If other financial mechanisms are inadequate, the alternative may be for the Federal Government to act as a "deep pocket" guarantor of Project debt, lease obligations and equity returns.

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The foregoing Sections outline an array of financing alternatives which are available to the CRBR Project. While the Task Force prefers no single financing approach, the following Sections describe in broad terms one possible financing program which seems promising.

VIII. Possible Financing Entity

- o The CRBR Project is faced with the need for significant funds; and without specific legislation, it would be unable to obtain such funds.

- o Such legislation may be needed to provide necessary warranties and tax incentives. It is also needed to create a financing entity which can use those warranties and incentives.

- o That entity can take several forms but, in any event, it should be designed to bring the Federal Government and a group of private investors together in a single enterprise so as to enable completion (through combined Federal/private financing) of an important R & D facility on which more than $1.5 billion has already been spent and which it would be foolhardy to junk.

- o Accordingly, the following format is suggested as a basis for further study and review:

  (a) Its name: whatever it is finally named, it is hereinafter referred to as the "Partnership."

  (b) The form: A public/private joint venture, created by Federal statute, encompassing both Government and private investment capital.

(c) Partners would include a newly created Federal corporation (or the DOE) as general partner and a group of private investors as limited partners.

(d) The limited partners might be individuals, corporations, or partnerships, depending on tax and regulatory considerations.

(e) The Partnership would be entitled to receive and allocate tax benefits among its partners.

(f) Ownership of the Project should be vested in the Partnership. Care should be taken not to disturb present licensing arrangements, but the Partnership should be provided with enough of the characteristics of ownership so that tax deductions and credits can be allocated among the limited partners.

(g) TVA would operate the Project and wheel power produced pursuant to a keep-whole reimbursement contract.

(h) At the conclusion of operations and recovery by private investors of their investment, title would revert to the Federal Government. Provision should also be made for decommissioning and waste disposal responsibility to remain in the Federal Government.

IX. Powers of the Partnership

The Partnership should have the following powers, among others:

- To issue its own debt obligations with Federal warranties, which could include borrowings from the Federal Financing Bank (FFB),* and/or without Federal warranties.

- To issue limited Partnership equity interests and to allocate tax benefits among the limited partners;

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* Alternatively, the Partnership could have the right to sell notes to the U.S. Treasury and Treasury would be obligated to purchase such notes.

- o To pledge the proceeds from its contracts and agreements as security for its debt, lease, joint venture or Partnership obligations;
- o To ratify and assume obligations under existing contracts and to enter into new purchase, construction and operating agreements, to buy and sell power, to sell and lease back facilities and fuel, etc.;
- o To obtain and hold title to patents and to license the use of such patents worldwide;
- o To enter into appropriate joint ventures related to the CRBR Project;
- o To be exempt from the Public Utility Holding Company Act and the Federal Power Act and not to be considered a regulated public utility for any purpose, state or Federal.

X. Priority Assessment of Actions Needed

In addition to the legislative action needed to create the Partnership with the powers set forth in Section IX, it must be given enough financial substance to allow it to function. Actions required to provide that financial substance have already been described. They are listed below, with only moderate additional amplification, because the listing is intended primarily to indicate their relative priority.

(1) Assurances must be provided as to completion, licensability and operability.

- o Such assurances must be unconditional if the required funds are to be obtained, especially in view of the uncertainties surrounding the outstanding WPPSS obligations.
- o In the event the Project is not completed, licensed and placed in operation, private investors would be entitled to recover the capital they had provided plus a return thereon.

(2) Assurances must be provided as to the amount of power the Project will produce.

(3) Power purchase contracts must be provided for the Project's full output at an assured price.

- Such contracts may represent either direct Federal power purchases or third-party purchases backed by Federal assurances.

- As mentioned earlier, such assurances with regard to power purchases and the price thereof have statutory precedent in the Energy Security Act where, as here, the need for future secure energy justifies such support.

(4) Provide a Bankable Commitment that adequate Federal funds (at least $1.4 billion) will be appropriated after FY 1983, or, if not, that private investors would be entitled to recover the capital they had provided plus a return thereon.

- The commitment should apply to the period from FY 1984 through FY 1990.

- It should provide for additional appropriations thereafter until the Project is licensed and achieves a commercial level of reliable operation.

- It should be sufficiently firm to be Bankable.

- Although the Congress does not normally appropriate funds for more than a year at a time, it should empower the DOE (i) to enter into the sort of commitment described above and (ii) to borrow from the FFB or from the U.S. Treasury the funds necessary to meet such commitments.

(5) Assure that project-related tax incentives can be allocated among the limited partners, as is customary for all large construction partnerships.

- These tax incentives, which are generally available to the owners of any large construction project, include investment

tax credits, accelerated depreciation and the immediate deductibility of certain overhead and operating expenses.

- It is customary to allocate such project-related incentives among the partners.

- Consequently, the allocation of these incentives among the Project partners would in no way provide a wind-fall for investors.

- All expenditures in excess of the Project's market value might be treated as R & D expenditures deductible by the limited partners. This was the formula used in 1955 to aid in financing Dresden Unit Number One (the first privately financed U.S. nuclear power reactor), whereby all expenditures by the Nuclear Power Group (a financing consortium) in excess of the commercial value of the plant were allowed as immediate tax deductions.

- In case the foregoing conventional tax incentives prove inadequate to provide the capital required, a number of new approaches might be considered. For example:

    - A special energy tax credit might be provided, applicable solely to the Project.

    - The Partnership might be empowered to enter into arrangements with the City of Oak Ridge to issue tax-exempt industrial development bonds backed by the Partnership and without regard to the so-called two-county rule.

For further discussion of the matter of tax incentives, see the appendix.

CONCLUSION

The Task Force concludes that the Clinch River Project can support significant private investment, and that the present Government/private business relationship can be enhanced, to the benefit of the entire nation.

From the viewpoint of the Federal Government, the benefit of obtaining private CRBR financing would be a near-term reduction in Federal budget requirements and increased private participation in the Project. Clearly, Federal assurances, warranties, and tax incentives will be needed in order to attract private financing. However, many of the proposed assurances are contingent and would not be called upon unless the Project failed to perform as expected, or the Government failed to complete the Project on schedule or the power revenues were substantially less than projected. Moreover, the Task Force assumes that the financing arrangements will reserve to the Federal Government the residual value of Project assets.

The Task Force stands ready to assist in determining how best to proceed.

Respectfully submitted,

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Tax Incentives

Taxes and tax incentives are significant elements in capital costs. The cost of financing is increased to the extent that the investor must pay tax on his investment return, while combinations of tax incentives can both lessen the burden of taxes on the investor's return and, in addition, provide a positive cash flow (thus producing, through the tax system, a stimulus to desired expenditures).

Predictably, such combinations of incentives are popular with the tax-paying public and unpopular with the Treasury Department. They tend also to be popular with Congress because they enable it to encourage research and modernization expenditures without directly appropriating federal funds.

Existing tax incentives for investment come primarily in three forms:

(1) Deductions: the right to deduct costs against income. This is, of course, not a special incentive unless and to the extent that (i) the costs deducted exceed the costs actually incurred, (ii) the costs are deductible in advance of the period in which they are economically incurred, in which case there is an acceleration of tax reduction, which is equivalent to an interest-free loan for the period of acceleration, or (iii) the costs are, in effect, attributable not to the stream of income against which they are de-

ducted, but to another stream of income which is exempt from tax.

R & D deductions. Of special importance to this project would be an R & D deduction equivalent to that portion of total project expenditures represented by the estimated excess of such expenditures over the commercial value of the completed facilities as measured by the cost of conventional facilities of the same character.

(2) Tax credits, such as the investment tax credit and the energy tax credit, which reduce the taxpayer's final tax liability. The investment tax credit, for example, will reduce tax liability $10 for each $100 of qualified investment, and the energy tax credit, if applicable, will reduce tax liability by an additional amount ranging from $10 to $15 under existing law (depending on the type of energy property involved). Prior to this year, those credits did not reduce the amount of taxpayer cost which could be depreciated. Thus, if a taxpayer paid $100 for an asset eligible for $20 of ITC and energy credit, the credits were immediately available and the taxpayer's real cost was effectively $80. Nonetheless, the taxpayer was permitted to depreciate the entire $100. Thus, the value of the two credits consisted of two elements: (i) $20 plus (ii) the right to depreciate $20 which was not in reality an economic cost. The value of that second element depended upon the period over which the depreciation was allowable, but for assets of medium life, a

$20 credit could produce a reduction of more than that in the cost of capital. The 1982 Tax Act modified this result by providing a reduction in the depreciation base equal to 50% of the amount of the credit (with some optional treatments not here important). In sum, to the extent that credits do not produce a basis adjustment, the value of the credit is larger than the credit percentage indicates.

(3) Exemption of investment income. The income produced by a particular investment may be categorically exempted from tax. In order to understand the interaction of this exemption incentive with other incentives, it is important to think of an investment as economists do (and not as accountants and lawyers do), i.e., as an expenditure which produces a stream of gross income which is then divided among two classes of claimants, creditors and equity owners.

The device widely used to exempt a portion of the income stream is the Industrial Development Bond (IDB), which exempts from tax that portion of the income from the investment which flows to creditors holding such bonds.

Optimum Combination of Incentives

An optimum combination of incentives would maximize in a single transaction all of the above three elements. If, for example, 90%

of a project could be financed with IDB's and the deductions and credits attributable to the entire cost of the project could be preserved for use by the equity owners, the total available tax benefits would be substantial and might produce tax deductions and credits to the equity owner in excess of his tax burdens. If the aim were to minimize total financing costs, it would be important (in that event) to reduce the amount of debt and increase the amount of equity to a point where the tax benefits produced exactly the desired level of cash flow, thus providing the minimum required equity return.

The Treasury Department is understandably critical of such tax planning and has for some years been chipping away at the rules in order to prevent it. As a result, today's applicable rules are a complex network of provisions, limitations, exceptions, cross-exceptions, etc., which can be satisfactorily described only in the context of specific proposals.

For present purposes, it may be sufficient to observe that broad general concepts are in place which could permit an optimum combination, and that one-shot modifications in existing limitations and exceptions would be achievable through legislation if there were a Congressional desire to make the overall project work.

Such legislative amendments would not need to be included in the Internal Revenue Code; but they would almost certainly require approval by the Congressional tax-writing committees, as disting-

uished from the committees having jurisdiction over energy, appropriations, etc.

Equity Ownership

Tax incentives which come in the form of deductions and credits can be fully utilized only by entities which have sufficient taxable income from other sources to absorb those deductions and credits. The level of incentives provided by present depreciation and ITC rules alone is sufficient that, even in an average situation, the taxable income flowing to the equity owners of a new project may not be sufficient fully to absorb the available deductions and credits. The problem is exacerbated if additional credits (such as the energy credit) are available or if there is a significant degree of financing available from other sources.

Thus, if the deduction and credit incentives are to be fully utilized, it becomes necessary to have some legal mechanism to permit them to be flowed through to others (normally equity owners) who can utilize such benefits. (Deductions and credits do not, of course, flow through to ordinary stockholders, so that an equity financing in the form of a conventional public issuance of stock will not achieve the desired result.) Two "flow-through" structures are typically used: (i) a partnership which owns and operates the project, or (ii) a partnership which leases the project to an opera-

tor. There is ample precedent for widely syndicated participation in owner-operator partnerships and, to a lesser degree (because of limitations on ITC in the hands of individual lessors), in lease partnerships. Where wide distribution is desired, it is normally necessary to limit the potential liabilities of individual investors by using a "limited partnership".

In the case of both operating and lease partnerships, if partnership debt is nonrecourse, the so-called "at risk" provisions in existing tax rules generally prevent the full flow-through of depreciation and (subject to certain exceptions) credits where the partners are individuals or closely held corporations. Thus, unless a special exception were made, it would be desirable to confine the equity participation to widely held corporate investors. Even then, if such investors were limited partners, the flow through would not work under existing rules unless the indebtedness were nonrecourse. That makes it absolutely essential that either the indebtedness be backed by an assured and ample cash flow or some legislative exception to the "at risk" rules be obtained.*

A further problem is that individual or corporate partners in a project which constitutes a regulated public utility may themselves be (or fear they may be) subject to public utility rules.

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* One possibility would be a mechanism to allow tax benefits associated with this single project, on a one-shot basis, to be transferable to any investor providing significant new capital therefor.

Thus, if the partnership were structured as an operating entity, it may be practical to sell equity participation only to other public utilities. In order to avoid such difficulties, the equity investors might assume the status of owner-lessors, who in turn were to lease to some operating entity. This would normally avoid the regulated public utility problems, but would entail either compliance with or modification of another complicated set of tax rules relating to lessors, all of which are to some extent in flux at this time, but which could almost certainly be temporarily held in abeyance through special legislation.

Debt Financing

Present rules permit the issuance of IDB's for electrical generation only in the case of the "local furnishing" of electricity. This has been interpreted to mean distribution solely within a territory no larger than two counties. The "two-county" rule is a peculiar rule with a peculiar history. Some modifications of it might be possible, on a one-shot basis, but any general relaxation of the rule would open the way for massive tax-exempt financing of electrical generation, which is a frightening spectre to both Congress and the Administration. Unless such fears can somehow be put to rest, the use of IDB's will be difficult to achieve.

Exempt financing would, of course, be available if equity ownership of the facility were in a state or local government entity

But in that case, the positive cash flow benefits of deductions and the investment credit would be unavailable.

It is possible for Congress to authorize the issuance of tax-exempt debt by a new, specially defined not-for-profit corporation which would fit this case. While such an authorization would be plowing new ground, it should not be rejected out of hand.

Miscellaneous Observations

The present energy tax credit has limited applicability and is, in any event, scheduled to expire. Some kind of legislative action would, therefore, clearly be required in order to make that credit or something comparable to it available to the project in question.

If some way could be found to issue tax-exempt debt, the general rules applicable to tax-exempt financing would permit a limited amount of investment of the proceeds in taxable securities pending construction and to some extent after construction. This potential is governed by the so-called "arbitrage rules", which are also complex. These, too, could be relaxed for a special case if Congress desired to do so.

Conclusion

Under optimum circumstances, the tax benefits potentially

available could provide significant additional funds for this project. Such benefits could be provided without having to create basic new concepts or provisions, but coming close to the optimum combination described would almost surely involve some legislative enactments which would require very careful structuring.

No tax windfall. It is important to note that all of the tax incentive structures described have the effect of reducing the cost of the capital investment and do not have the effect of providing anything other than normal returns to private investors. The net result is that the private investors will have a cash flow that returns their investment, together with a reasonable market rate return---no more, no less. The source of their cash---the fact that it comes in the form of tax benefits---is of no consequence to them; they are interested only in dollars. It is immaterial to them who transmits the dollars. Thus, any contribution in the form of tax incentives will flow, in economic effect, not to the investors, but to the project, itself, with any excess being ultimately returned to the federal government through the operation of federal/private financing arrangements already in place.