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REPORT TO THE CONGRESS

Cost And Schedule Estimates For The Nation's First Liquid Metal Fast Breeder Reactor Demonstration Power plant

Energy Research and Development Administration

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This is our report on the cost and schedule estimates for the Nation's first liquid metal fast breeder reactor demonstration powerplant.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget, and the Administrator, Energy Research and Development Administration.

Comptroller General
of the United States

Contents

ABBREVIATIONS

CRBR	Clinch River Breeder Reactor
ERDA	Energy Research and Development Administration
FFTF	Fast Flux Test Facility
GAO	General Accounting Office
LMFBR	Liquid Metal Fast Breeder Reactor
NRC	Nuclear Regulatory Commission
PMC	Project Management Corporation
TVA	Tennessee Valley Authority

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

COST AND SCHEDULE ESTIMATES FOR THE NATION'S FIRST LIQUID METAL FAST BREEDER REACTOR DEMONSTRATION POWERPLANT
Energy Research and Development Administration

D I G E S T

WHY THE REVIEW WAS MADE

GAO reviewed the cost and schedule estimates for constructing and operating the Nation's first liquid metal fast breeder reactor demonstration plant--the Clinch River Breeder Reactor project--because of

--the importance of the liquid metal fast breeder reactor program to the Nation's future energy posture,

--the contribution the demonstration powerplant is expected to make in providing data on the economical and environmental value of the liquid metal fast breeder concept,

--the significant Federal funds involved, and

--congressional concern over increases in the estimated cost of the project.

GAO recently released another report on the past, present, and future of the breeder and expects to release shortly an issue paper on the broad range of promises and uncertainties of the total breeder program.

FINDINGS AND CONCLUSIONS

The Clinch River Breeder Reactor will have a designed capacity of 350 megawatts of net electrical output and will be located on the Clinch River near Oak Ridge, Tennessee. The major objective of the project will be to help demonstrate the value and environmental desirability of using liquid metal fast breeder reactors as a practical and economic option for generating electric power. The current schedule calls for the project to achieve initial criticality by July 1982, with commercial operation to begin early in 1983. (See p. 2.)

Cost estimates

In August 1972 the cost of the Clinch River Breeder Reactor project was estimated at $699 million. Since then, the estimated project cost has greatly increased. In September 1974 the project was estimated to cost about $1.7 billion. According to the Energy Research and Development Administration (ERDA) --the Federal agency in the joint Government-industry arrangement for carrying out the project--the 1974 estimate was a new estimate and not an updating of the 1972 estimate. Several preliminary or working estimates were prepared in June and August 1974 to compute the September 1974 estimate. (See p. 5.)

The greatest change in the estimated cost of the project took place between August 1972 and June 1974. The preliminary project estimate prepared in June 1974 incorporates a better definition of the project scope, including design changes, the effects of inflation, cost trends in the utility supply and manufacturing industry, and increased environmental and licensing constraints. This cost estimate, along with the detailed design, was the basis for all subsequent preliminary and official cost estimates. Changes in the cost estimate between June 1974 and September 1974 reflect some changes in the scope of the project but primarily reflect changes associated with the assumption of risk, the rate of inflation, and the contingencies to be applied to the project. (See p. 5.)

The June preliminary estimate of $1.9 billion was developed through thousands of individual estimates. Thus it was a "bottom-up" approach to estimating the total cost of the project. The cost estimate was based on the experience of recent light-water reactor plants and other projects, budgetary estimates from potential suppliers, and engineering judgment. The estimate covered costs through a 5-year demonstration period to 1987 and included escalation for inflation at an average annual rate of 8 percent. This preliminary estimate was prepared by project participants, with a very high probability --greater than 95 percent-- that the estimate would not be exceeded. (See pp. 5 to 11.)

Project participants' review of the June 1974 preliminary estimate disclosed certain errors and omissions, and the total project cost was adjusted to about $2.1 billion.

Meanwhile, the project steering committee--established to provide policy guidance for the project--expressed deep concern over the amount of the estimate. The committee concluded that:

"* * * with such high costs, the project could be in trouble. Steps must be taken to confirm the adequacy of the design and reasonableness of the cost estimates. An explanation of the increases is urgently needed. Further means of reducing costs should be identified." (See p. 7.)

In reviewing and revising the June preliminary estimates the project participants changed the methodology used to estimate project costs. Some revisions to the June preliminary estimates were made on a line item or individual task basis. Major adjustments were made on the basis of certain management decisions that were applied to entire cost categories. The major changes were to lower the anticipated escalation rate from an 8 percent average annual rate for the entire project to a 5-1/2 percent average annual rate for all of the project except 1975, which would remain at 8 percent, and to lower the provisions for contingencies. (See p. 8.)

The net effect of the adjustments and revisions to the June preliminary estimates was to reduce the estimated project cost from about $2.1 billion to about $1.5 billion.

The August preliminary estimate of $1.5 billion reflected about a 90 percent probability that actual cost would not exceed the estimate. (See p. 8.)

An ERDA internal review team evaluated the August preliminary estimate and suggested that it be increased to show the complexity of the project and current economic conditions. The recommendation of the team resulted from an assessment of the bases, makeup, and confidence level of the major cost categories. The project participants accepted the recommendations but decided that all increases should be identified as contingency estimate increases to strengthen the likelihood of meeting the contractors' lower cost estimate.

The amount included in the August preliminary estimate for escalation was also increased. The management of the project decided to use an average annual rate of 8 percent for the entire time frame of the project on the basis of various governmental and industrial sources' economic trend projections and on information provided by ERDA's internal review team. The August preliminary estimate provided for escalation at an average annual rate of 5-1/2 percent for all years except 1975, for which the rate was 8 percent. (See pp. 8 and 9.)

The adjustments that resulted from the August preliminary estimate evaluation increased project cost from $1.5 billion to $1.7 billion in September 1974. (See p. 9.)

GAO was not able to determine whether the project could be constructed and operated for $2.1, $1.5, or $1.7 billion, because

--the project was only in an early design stage,

--the project is a first-of-a-kind and sufficient and useful data was not always available to develop firm estimates,

--professional engineering judgment was a factor in estimating project costs,

--cost escalation for a long-term project is very speculative, and

--failure to meet the schedule could increase cost.

The methodology used to develop the June estimate was, in GAO's view, a reasonable approach to estimating costs for a project in the development stages. Although certain assumptions were made and judgment was necessarily a factor in compiling the estimate, a detailed approach was followed. (See pp. 9 and 24.)

In estimating the impact of changes in the design of the project and the underlying assumptions concerning contingencies and escalation on

the estimated project cost, the same methodology was not wholly followed in August and September. Some revisions were made on a line item basis, but major adjustments were made to entire cost categories without a detailed analysis of whether the proposed reductions could be applied to all the individual items in the category. GAO recognizes that the proposed adjustments may, in fact, result in lower project costs than were estimated in compiling the June preliminary estimates. The amount of the changes, however, was more speculative than it would have been had the same methodology used in compiling the June preliminary estimates been applied to the revisions.

Further, the June preliminary estimates were compiled by the project participants with a high probability (greater than 95 percent) that cost overruns would not occur. Revisions to the June preliminary estimates decreased the probability (90 percent) that the current estimate would not be exceeded. Project participants emphasized, however, that they believed a 90 percent probability was a more realistic goal. (See pp. 9 and 10.)

It should be emphasized that the total estimated cost to construct and operate the project may change, either higher or lower, as early designs are finalized and actual cost escalation is experienced. (See p. 10.)

Schedule estimate

The architect-engineer prepared the project schedule in considerable depth and detail. Each item to be procured and installed was integrated with the major elements of design, procurement, and construction. A detailed estimate was made of the quantities to be installed in each system and building and a detailed installation sequence was prepared. The project schedule was influenced by anticipated manpower availability, delivery times for major project components, schedules for light-water reactor plants and another test facility, and professional engineering judgment of the architect-engineer and other project participants. (See p. 26.)

Project participants identified several potential problems that could lead to schedule delays. They include

--failure to receive adequate funding,

--delays in the licensing process,

--delays in delivery of long-leadtime material and components,

--unavailability of craftsmen, and

--major design changes.

As slippages occur, the project participants will have to reassess the schedule to determine what adjustments, if any, need to be made to minimize the impact of the slippage on the project. Rescheduling of the project may increase project costs

through extension of the planned completion date or through increased labor or material costs. ERDA has estimated that early delays in the project could cause an increase in the project cost of about $10 to $15 million for each month of delay. The project has already been delayed about 3 years and has caused delays in the overall breeder program. Further delay in the project could have the same effect. (See pp. 26 to 32.)

RECOMMENDATIONS AND SUGGESTIONS

This report contains no recommendations.

AGENCY ACTIONS AND UNRESOLVED ISSUES

GAO disucssed this report with ERDA officials and included their comments where appropriate. ERDA believes the report is factually correct but that it could be enhanced if a number of points were stressed. (See p. 45.)

MATTERS FOR CONSIDERATION BY THE CONGRESS

This report provides the Congress with cost and schedule information on the project that is intended tp demonstrate the viability of the liquid metal fast breeder reactor concept.

CHAPTER 1

INTRODUCTION

Most of the nuclear reactors in use, under construction, or planned are light-water reactors--reactors that use either pressurized or boiling water as a coolant surrounding the nuclear fuel.

Differing from these reactors are the "breeders," which create for the future more fuel than they consume. There are several breeder concepts--the molten salt breeder, the light-water breeder, the gas-cooled fast breeder, and the liquid metal fast breeder. Although the Energy Research and Development Administration (ERDA)[1] has research programs to develop all of these breeder concepts, ERDA selected the liquid metal fast breeder reactor (LMFBR) development program as the highest priority breeder development program principally because of (1) predicted performance, (2) industrial support, (3) a broad base of existing technological experience, and (4) proven basic feasibility. The LMFBR concept is being developed in other industrially advanced countries of the world, including France, West Germany, Japan, the Soviet Union, and the United Kingdom.

THE LMFBR PROGRAM

The objective of the LMFBR program is to develop a broad technological base with extensive electric utility and industrial involvement which will lead to establishing a strong, competitive, commercial breeder industry--currently estimated to be in the 1990s. ERDA is concurrently proceeding along two lines of effort--the base technology program and the Clinch River Breeder Reactor (CRBR) demonstration plant program.

Under the base technology program, engineering development, manufacturing, and proof-testing efforts have been and are being expended by ERDA, in conjunction with industry, to develop realistic technical and economic bases for initiating an LMFBR demonstration plant program. The demonstration plant

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[1]In October 1974 Public Law 93-438--cited as the Energy Reorganization Act of 1974--abolished the Atomic Energy Commission. The act established ERDA and the Nuclear Regulatory Commission (NRC). ERDA was established on January 19, 1975. Our review was substantially completed before the provisions of the act became effective. Our report, however, refers to ERDA and NRC when the function is the responsibility of the newly organized agencies.

program is intended to be the key to the transition of the LMFBR program from technology development to large-scale commercial use.

One of the major facilities in developing the LMFBR is the Fast Flux Test Facility (FFTF) under construction near Richland, Washington. This is a key test facility in the LMFBR program; its primary mission is to provide a well instrumented and controlled environment to meet all the program's fuel and material irradiation needs. In addition, design and construction of the facility have contributed greatly to (1) advancing fast reactor safety and component and system technology and (2) developing technological, design, and industrial capabilities required not only for the first demonstration plant but also for the full development of an LMFBR industry. The FFTF was one of the inputs used to develop estimates for the CRBR demonstration plant. FFTF's large cost growth and schedule delays since congressional authorization in 1967 were known and considered in compiling the 1974 preliminary CRBR estimate.

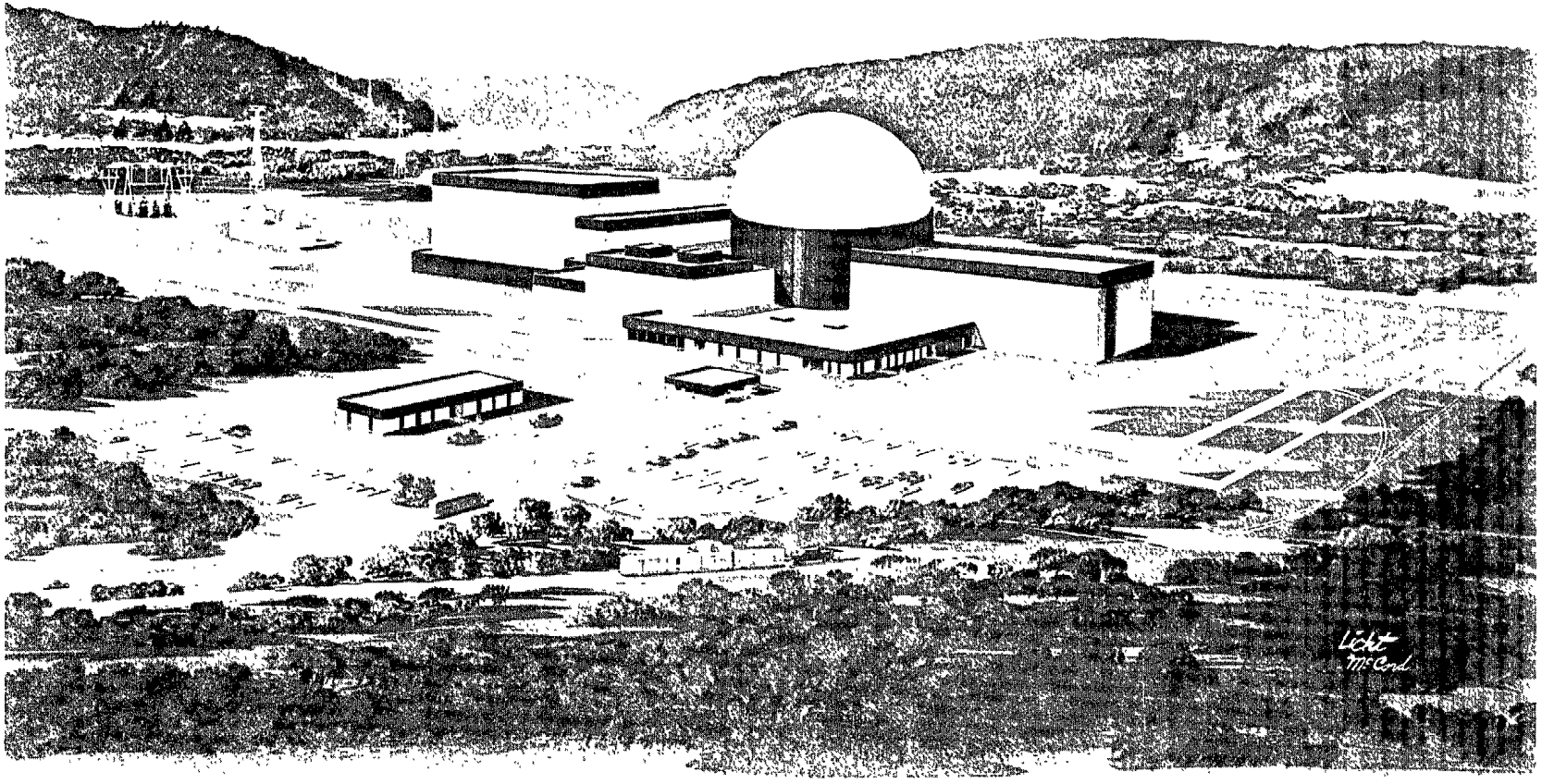
CRBR will be the Nation's first LMFBR demonstration powerplant. It will have a designed capacity of 350 megawatts of net electrical output and will be on the Clinch River near Oak Ridge, Tennessee. ERDA currently estimates that the design, development, construction, and 5-year operation of this plant will cost $1.7 billion. CRBR is scheduled to achieve initial criticality by July 1982. The project will then have an operational test period, and commercial operation will begin in early 1983.

The major objectives of the CRBR project will be to (1) demonstrate the environmental desirability of the LMFBR concept, (2) confirm the value of the LMFBR concept for conserving important nonrenewable natural resources, (3) develop important technological and economic data, (4) establish an ability to license such a reactor, and (5) verify certain key characteristics and capabilities of LMFBR plants for operation in a utility environment, such as safety and reliability. An artist's sketch of the proposed facility is shown on the following page.

CRBR PROJECT PARTICIPANTS

The CRBR project is a joint government-industry effort. The principal contracting parties are ERDA, Tennessee Valley Authority (TVA), Commonwealth Edison Company, Project Management Corporation (PMC), and Breeder Reactor Corporation.

PMC, a nonprofit organization, has the overall management and contracting responsibility for the project. PMC is



Artist's concept of the Clinch River Breeder Reactor Plant

responsible for seeing that the design, development, construction, testing, and operation of the CRBR demonstration plant is carried out and for establishing and using a project steering committee. A project steering committee, composed of representatives of Commonwealth Edison Company, TVA, and ERDA, was established to provide policy guidance for the project.

ERDA assists PMC and endeavors to obtain additional authorization and funds for the continued and effective conduct of the CRBR project. ERDA also is responsible for the project's nuclear steam supply system and for assuring that the nuclear system is designed, built, and tested according to project requirements and that it meets project objectives.

Breeder Reactor Corporation, a nonprofit organization, coordinates the Nation's electric utilities' financial and other types of participation in the demonstration plant. It also serves as the project's principal liaison with these utilities. The Nation's electric utilities are expected to contribute $257 million to the project.

Commonwealth Edison Company will provide staff and certain purchasing services for PMC.

TVA will provide the plant site, staff for PMC, and accounting and public information services for the plant. TVA will also purchase the electrical output during the plant's demonstration period and has the option to operate and maintain the plant after the demonstration period.

Westinghouse Electric Corporation is serving as the lead reactor manufacturer and Burns & Roe, Inc. is serving as the architect-engineer.

General Electric Company and Atomics International, a Division of Rockwell International, are subcontractors to Westinghouse.

On March 10, 1975, ERDA submitted to the Joint Committee on Atomic Energy proposed legislation and other documents intended to transfer management responsibility for the CRBR from PMC to ERDA. ERDA believes that this change, if approved by the Joint Committee, will strengthen and streamline the management of the CRBR.

CHAPTER 2

CRBR PROJECT COST ESTIMATE

The current estimated cost to construct and operate CRBR is $1.7 billion. The estimate includes costs from 1973 through a 5-year demonstration period to 1987. Since the initial estimate in August 1972, the estimated cost to construct and operate the project has greatly increased, as shown in the table on page 6.

Project participants stated that there were only two official project estimates--the August 1972 estimate of $699 million and the September 1974 estimate of $1.7 billion. According to ERDA, the 1974 estimate was a new estimate --based upon current CRBR plant designs--and not an updating of the 1972 estimate. In addition, there were several preliminary or working estimates prepared in June and August 1974.

The most significant change in the estimated cost of the project took place between August 1972 and June 1974. The project estimate prepared in June 1974 reflects a better definition of the project scope, including design changes, the effects of inflation, cost trends in the utility supply and manufacturing industry, and increased environmental and licensing constraints. This cost estimate along with the detailed design was the basis for all subsequent preliminary and official cost estimates. Changes in the cost estimate between June 1974 and September 1974 reflect some changes in the scope of the project but, primarily reflect changes associated with the assumption of risk, the rate of inflation, and the contingency factors to be applied to the project. A more detailed explanation of the development of the project cost estimates is presented in the remaining sections of this chapter.

The August 1972 estimate of $699 million, prepared by the then project participants (PMC, TVA, Commonwealth Edison, and ERDA), included operational costs during a 5-year demonstration period and was developed from cost information submitted in the form of proposals by reactor manufacturers. This cost information was supplemented by cost information from TVA, Commonwealth Edison, and ERDA.

The $699 million estimate was presented to and discussed before the Joint Committee on Atomic Energy in September 1972. It was represented as being ERDA's best estimate, based on preliminary information. Although it was agreed that estimated costs could change, the Joint Committee was told that there was no information, at that time, to indicate that the

CRBR Project Cost Estimates (note a)

Cost element	August 1972 estimate	Preliminary 1974 estimates: June original	June revised	August	September 1974 estimate
	(000,000 omitted)				
Base costs (major plant investment and development) (note b)	$313	$ 909	$ [c]909	$ 790	$ 790
Base costs (other plant investment, development, and operations) (note b)	171	176	285	223	223
Contingencies (note d)	56	220	259	141	225
Escalation	159	557	612	325	498
Total	$699	[e]$1,862	[e]$2,065	$1,479	[f]$1,736

[a] ERDA program direction and administration costs are not included. This treatment is consistent with ERDA's budget justification to the Congress where these costs are considered separately from program costs. Also, the cost of land for the project, furnished by TVA, is not included.

[b] Base costs include equipment, material, and labor costs which the project participants could reasonably anticipate for construction and operation.

[c] Equipment, engineering, and construction estimates were changed, but the net difference was less than $1 million.

[d] Contingencies are allowances included in an estimate to cover unforeseen costs that may occur or to provide protection against specific risks.

[e] Project participant reviews of the original June 1974 preliminary estimate disclosed certain errors and omissions which increased the total project cost. The corrected June preliminary estimate was used in developing the August 1974 preliminary estimate.

[f] In March 1975, officials of ERDA's Division of Reactor Research and Development forecasted that the CRBR would cost $1,771 million.

CRBR project could not be accomplished within the $699 million estimate.

The project participants developed the original June 1974 preliminary estimate from thousands of individual task estimates. Thus it was a "bottom-up" approach to estimating the total project cost.

The original June 1974 preliminary estimate was discussed at a meeting of the project steering committee on June 28, 1974. The minutes of the meeting showed that ERDA's Reactor Research and Development Division staff and the PMC staff believed the total project cost would range from $1.66 to $1.86 billion, depending on whether an average annual escalation rate of 5-1/2 percent or 8 percent was used. (An 8 percent average annual escalation rate was assumed in compiling the original June 1974 preliminary estimate.) Increases in plant costs, first-of-a-kind engineering, and price escalation were cited as major reasons for the increase in project costs since 1972.

The project steering committee expressed deep concern over the estimated amount. The committee concluded that:

> "* * *with such high costs, the project could be in trouble. Steps must be taken to confirm the adequacy of the design and reasonableness of the cost estimates. An explanation of the increases is urgently needed. Further means of reducing costs should be identified."

An ERDA internal review team examined the original June preliminary estimate and identified errors and omissions amounting to about $210 million. About $188 million related to research and development projects that could be properly charged to this project. With the correction of errors and the addition of omissions, the original June preliminary estimate was increased to about $2.1 billion.

In discussing the original and corrected June preliminary estimates during a meeting of the project steering committee on July 17, 1974, the architect-engineer said that, although it was unable to identify specific measures to substantially decrease the cost estimate, it was willing to further examine ways to decrease any possible duplication of effort and to work with Westinghouse and ERDA toward decreasing the project cost. The architect-engineer also said the basis for its estimates were sound and thought to be realistic and individuals from other organizations who reviewed this part of the estimate generally agreed that it was reasonable but tight.

A Westinghouse representative at the same meeting said Westinghouse was not happy that the project cost estimate was so large, but said it was prepared to insure that cost overruns would not occur. At the end of this meeting, the project steering committee again directed the PMC General Manager to examine the preliminary cost estimate to insure that it was realistic and to provide a comprehensive explanation of the differences between the August 1972 and June 1974 preliminary estimates.

In reviewing and revising the June preliminary estimates, the project participants changed the methodology used to estimate project costs. The June preliminary estimates were compiled by estimating and analyzing each task. In some instances revisions to the preliminary June estimates were made on a line item or individual task basis. Substantial adjustments were made on the basis of certain management decisions which were applied to entire cost categories. The major changes were to lower the anticipated escalation rate from an 8 percent average annual rate for the entire project to a 5-1/2 percent average annual rate for all years of the project except 1975 which would remain at an average annual rate of 8 percent, and to lower the provision for contingencies. (See pp. 16 to 20 for a more detailed discussion of the changes made to the June preliminary estimates.)

The net effect of the adjustments and revisions to the June preliminary estimates was to reduce the estimated project cost from about $2.1 billion to about $1.5 billion.

The revised preliminary estimate of $1.5 billion was presented to the project steering committee on August 26, 1974. In discussing the estimate, Westinghouse said it reflected the agreements reached among the project participants during an August 7, 1974, project steering committee meeting. During the August 7 meeting, an ERDA representative said ERDA did not want a buy-in (low) estimate or a padded (high) estimate. ERDA did want an estimate having a confidence level of 80 to 90 percent.

According to project participants, the August preliminary estimate of $1.5 billion has a 90 percent probability that actual equipment and engineering cost would not exceed the estimate. No probability was provided for construction or operating costs. The June estimates had a very high probability (believed to be greater than 95 percent) that the total estimate would not be exceeded.

The project steering committee accepted the August preliminary estimate and authorized the ERDA representative to present it to ERDA for consideration. An ERDA internal review team evaluated the August preliminary estimate and suggested

that it be increased to reflect the complexity of CRBR and current economic conditions. The recommendation of the team resulted from an assessment of the bases, makeup and confidence level of the major cost categories. Project participants accepted the recommendations but decided that all increases should be identified as contingency estimate increases to strengthen the likelihood of meeting the lower cost estimate prepared by the contractors.

The amount included in the August preliminary estimate for escalation was also increased. Project management decided to use an 8 percent average annual rate for the project's entire time frame on the basis of various governmental and industrial sources' economic trend projections and information provided by the ERDA internal review team. The August preliminary estimate provided for escalation at an average annual rate of 5-1/2 percent for all years except 1975 for which the rate was 8 percent.

The adjustments that resulted from the evaluation of the August preliminary estimate increased the estimated project cost from $1.5 billion to $1.7 billion in September 1974. On September 18, 1974, the project steering committee accepted the September cost estimate and authorized the ERDA representative to present it to ERDA for consideration.

A major factor in compiling the June, August, and September estimates was the evaluation of the project's reference design in light of the prior experience and professional and managerial judgment of the project participants. Because the estimates were based heavily on participants' prior experience, the CRBR project is a first-of-a-kind project in an early design stage, and the uncertain nature of cost escalation, we were not able to determine whether CRBR could be constructed and operated for $2.1, $1.5, or $1.7 billion. The project participants emphasized, however, that they unanimously agree that the project can be constructed for $1.7 billion.

The methodology used by the project participants in compiling the June 1974 preliminary estimates--analyzing each task to be done and estimating its cost--was reasonable for a project in the early stage of development. As noted earlier, the June preliminary estimate and supporting reference design were the basis for all subsequent changes in both the cost estimate and design of the project.

In estimating the impact of changes in the design of the project and the underlying assumptions concerning contingencies and escalation on the estimated cost of the project, the same methodology was not always followed. Some revisions were made on a line item basis, but adjustments were made to

entire cost categories without a detailed analysis of whether the proposed reductions could be applied to all the individual items in the category. We recognize that the proposed adjustments may, in fact, result in lower project costs than were estimated in compiling the June preliminary estimates. The amount of the changes, however, is more speculative than it would have been had the same methodology used in compiling the June preliminary estimates been applied to the revisions.

Further, the June preliminary estimates were compiled by the project participants with a very high probability of success (greater than 95 percent) on the basis that cost overruns would not occur. Revisions to the June preliminary estimates decreased the probability of success (90 percent) and presumably increased the chances that the current estimate would be exceeded. Project participants emphasized to us, however, that they believe a 90 percent probability of success is a more realistic goal.

It should be emphasized, however, that the total estimated cost to construct and operate CRBR, as in any project of this size, may change again--either higher or lower--as early designs are finalized and actual cost escalation is experienced.

JUNE 1974 PRELIMINARY COST ESTIMATE

The June preliminary cost estimate of $2.065 billion for the CRBR project comprised $1.194 billion for plant investment, development, and operating costs for a 5-year demonstration period; $259 million for contingency; and $612 million for escalation. The following table shows the major cost elements of the corrected June estimate.

Cost element		June estimate (000,000 ommitted)
Base costs (major plant investment and development cost)		
Equipment		$ 341
Engineering		346
Construction		222
Base costs (other plant investment, development, and operating costs)		285
		1,194
Contingencies		
Equipment	$77	
Engineering	41	
Construction	93	

Other plant, etc.	48	$ 259
Escalation		612
Total		$2,065

This preliminary cost estimate was based on the experience of recent light-water reactor plants and other projects, such as FFTF; budgetary estimates from potential suppliers; and professional engineering judgment. Although project participants considered the estimate to be sound and reasonable, they said there was a potential for change because of uncertainties, such as redesign of plant equipment, irregularities in the sources of supply, and the uniqueness of complexity of certain systems. The estimate was also qualified in that size and duration of the CRBR project made it sensitive to changes in economic conditions, environmental legislation, and decisions on licensing.

An ERDA internal review team examined the original June preliminary estimate of $1.862 billion and identified certain errors and omissions amounting to about $210 million. About $188 million of this amount was related to research and development projects. More projects were considered to be properly chargeable to the CRBR project because of a reinterpretation of legislation applicable to research and development projects. Of the $188 million, $165 million was base cost and $23 million was escalation. The remaining $22 million, for base cost and contingencies, was attributed to errors in computing the original June preliminary estimate.

Westinghouse and ERDA then revised the original June preliminary estimate. Research and development cost chargeable to the CRBR project was estimated at $145 million rather than $165 million. Of this amount, $120 million was base cost (see p. 38) and $25 million was contingency. The original June 1974 preliminary equipment, engineering, and construction estimates were reduced a total of $16 million, and operation and maintenance costs were reduced by about $4 million. These corrections, with corresponding changes in escalation estimates, resulted in a revised preliminary project cost estimate of $2.065 billion. Our discussion of the methodology used in developing the June 1974 preliminary estimates, in the following sections, shows these corrections by cost elements.

A schedule for the project and operation was also prepared. Delays in meeting the schedule will have an impact on project cost. ERDA has estimated that early delays in the project could cause an increase in the CRBR project cost of about $10 million to $15 million for each month of delay. As the project progresses, the impact of delays will lessen. A

more detailed discussion of the project schedule and some of its milestones are included in chapter 3.

Major plant investment and development cost

The major cost elements in the plant investment and development cost categories were equipment, engineering, and construction. These estimates represented about 54 percent of the total June preliminary estimates. Because a large percentage of the costs were in this category, we reviewed the methodology used in and the justification supporting the estimates for 122 line items amounting to a total estimated base cost of $306 million, or about 33 percent of the total base costs in this category. We also reviewed the methodology and reasons for the application of contingency factors to these base costs.

Westinghouse had overall responsibility for consolidating the CRBR project cost estimate. The reactor manufacturer with lead technical responsibility for a system was assigned the task of consolidating the cost estimates for that system. The architect-engineer had total responsibility for developing a cost estimate for the nonnuclear part of the CRBR project. These procedures resulted in a crossflow of estimates between reactor manufacturers and the architect-engineer.

Equipment cost estimate

The equipment cost estimate included $341 million for base costs and $77 million for contingencies.

Cognizant engineers and managers developed the equipment base estimate on a line item basis. There were 1,265 line items in the equipment cost estimate. We reviewed the methodology and justification supporting the estimate for 44 equipment line items totaling $186 million, or about 55 percent of the total equipment costs.

The estimated costs of the 44 line items were based on (1) vendor estimates, (2) catalog pricing, (3) FFTF cost experience, (4) in-house fabrication estimates, or (5) a combination of these estimating techniques. In most cases, the estimator's professional judgment was a factor in applying these techniques and in developing the estimate. Examples of the methods used to develop estimates for equipment items are included as appendix I.

In estimating the $77 million contingencies for equipment, a 24 percent contingency factor was applied to the $296 million cost estimate for equipment located in the nuclear part of the plant. These contingencies consisted of:

--A general contingency of 10 percent based on industry practices.

--A special contingency of 9 percent based on a Westinghouse review of each equipment line item for credibility. This review evaluated (1) the validity of the unit cost source, (2) the economic effect of the assumptions and limitations used in arriving at the equipment estimates, and (3) the comprehensiveness and detail of the system and item design.

--An additional 5 percent to offset the general willingness of estimators to directly relate contract prices of FFTF components and to accept catalog or sales office quotations without substantial consideration of CRBR application.

A contingency factor of 12.5 percent was applied to the remaining $45 million equipment cost estimate which the architect-engineer said was made up of more standard-type items of equipment, such as cooling towers and turbine generators. This factor represented an average of contingency factors for civil, electrical, and mechanical equipment based on experience on past projects.

Engineering cost estimate

The engineering cost estimate consisted of $346 million for base costs and $41 million for contingencies. These costs were for engineering services that were expected to be done by reactor manufacturers and the architect-engineer.

There were 425 engineering line items. The reactor manufacturer prepared the estimates for 367 of the line items, and the architect-engineer was responsible for the remaining 58 line item estimates. We selected 46 line item estimates prepared by the reactor manufacturers for detailed review to determine the basis used for estimating and the justification supporting the estimates. The 46 line items, totaling $81 million, represented 23 percent of the reactor manufacturers' engineering base cost estimate.

The engineering labor-hour estimates were based on the previous experience of the participants on the FFTF project, light-water reactor projects, and other projects such as the Southwest Experimental Fast Oxide Reactor, and was influenced by their professional engineering judgment. Several engineers said that they had discussed the estimates with other persons having reactor construction knowledge and that they had reviewed FFTF records. Provisional labor rates were then applied to labor-hours to arrive at the base cost engineering estimate. (See app. I.)

We did not make a line item study of any of the architect-engineer's estimates because all line item estimates were made in the same manner. The architect-engineer said the preparation of the cost estimate began with personnel of various architect-engineer sections developing estimates of staff-hours required each year to do assigned work. We were told that estimates were based on professional engineering judgment and past experience. The individually prepared estimates were compared to historical data and reviewed by management before being summarized as one total estimate.

The reactor manufacturers' base cost estimate was developed to insure that the work would be completed within the stated estimate. A blanket contingency of 10 percent, based upon the project participants' judgment, was added to the base cost to increase the probability of completing the project within the stated estimate.

The contingency factor of 20 percent, established for the architect-engineer's estimate, was similar to the contingency discussed above in that it was a percentage of unescalated base costs and it was based on the estimators' judgment.

Construction cost estimate

The construction cost estimate included $222 million for base costs and $93 million for contingencies.

There were 2,708 construction line item estimates. We selected 32 estimates for detailed review to determine the basis used for estimating and justification supporting the estimates. The 32 line items, totaling $39 million, represented about 18 percent of the construction base cost estimate.

The base construction cost estimate was generally based on (1) vendor estimates, (2) historical cost data, (3) FFTF experience, (4) extrapolation of the data on similar items, (5) labor productivity factors for determining labor requirements, or (6) a combination of these estimating techniques. In most cases the estimators' professional judgment was a factor in applying these techniques and in developing the estimate. (See app. I.)

In consolidating the overall construction estimate, a contingency allowance of about 42 percent, or $93 million, was added to base cost. The contingency allowance was based on professional engineering judgment and consisted of three factors: (1) a growth factor to cover increases in quantities which might occur during evaluation of the detailed design, (2) a specific contingency to cover uncertainties in each of

the estimating areas, and (3) a general construction contingency. The growth factor was initially included in the base costs by the architect-engineer; later, it was made a part of the contingency allowance.

Other plant investment, development, and operating costs

Other plant investment, development, and operating costs of $333 million represent about 16 percent of the total June estimate. The following table shows the cost elements constituting this category.

Cost element		June 1974 preliminary estimate --(000,000 omitted)--
Base costs		
Core fabrication		$ 94
Operation and maintenance		49
Project Management Corporation staff and services		47
Special nuclear material		18
Equipment development		120
Insurance		4
Revenue		-47
		$285
Contingency		
Core fabrication	$23	
Equipment development	25	48
Total		$333

Project participants developed these cost estimates on the basis of

--FFTF technology and cost experience,

--light-water plant fuel technology and historical experience in generating electric power,

--judgmental work forces and staff requirements, and

--interpretations of what research and development projects were properly chargeable to the CRBR project.

The methodology used in developing the June 1974 preliminary estimates for these cost elements is included in appendix II.

AUGUST 1974 COST ESTIMATE

The August preliminary estimate of $1.479 billion included $1.013 billion for plant investment, development, and operating costs for a 5-year demonstration period, $141 million for contingency, and $325 million for escalation.

Following is a comparision of the major cost elements of the June and August preliminary estimates.

Cost element	1974 preliminary June estimate	1974 preliminary August estimate
	(000,000 omitted)	
Base costs (major plant investment and development cost):		
Equipment	$ 341	$ 284
Engineering	346	293
Construction	222	213
Base costs (other plant investment development, and operating costs)	285	223
Subtotal	$1,194	$1,013
Contingency:		
Equipment	$77	$18
Engineering	41	19
Construction	93	53
Other plant, etc.	48	51
	259	141
Escalation	612	325
Total	$2,065	$1,479

The August preliminary base cost estimate was made through a combination of detailed analysis of parts of the June preliminary estimates and managerial techniques aimed at reducing certain cost categories on an overall basis. Approximately 50 percent of the adjustments were made on the basis of a detailed analysis and 50 percent were made on an overall basis.

Contingency cost adjustments made in developing the August 1974 preliminary estimate amounted to about $147 million, excluding safety design changes not included in the June preliminary estimates. The August preliminary contingency estimate was reduced by about $81 million on the basis of a statistical analysis. Our review also indicated that at least another $40 million had been deducted on the basis of project participants' revised professional judgments.

The August preliminary estimate used an annual average rate of 8 percent for fiscal year 1975 and 5-1/2 percent for other years. This resulted in reducing cost escalation by $287 million.

Major plant investment and development costs

The major cost elements in the plant investment and development cost estimates were equipment, engineering, and construction. These estimates represented about 60 percent of the total cost estimate.

An overall cost reduction of about $239 million was made in the equipment, engineering, and construction cost estimates. The reductions were based on

--more prudent application of ERDA program requirements for CRBR,

--simplification of certain systems, and

--lowering the project's probability of financial success to 90 percent.

Because these actions were expected to reduce base costs by $119 million and contingency costs by $120 million, the cost estimate for these categories was reduced by these amounts. In applying these techniques, certain judgments were made which were not readily subject to verification.

Some of the techniques used to reduce the cost estimates are discussed below.

Prudent application of Reactor Development and Technology standards (specific ERDA engineering and fabrication requirements)--Westinghouse reduced the reactor manufacturer's equipment estimate by 8 percent on the basis that reactor standards could be more prudently applied on the CRBR project. This technique reduced the estimated costs by $24 million.

The 8 percent was based on a February 1974 task force study of the implementation of reactor standards on the FFTF contract. The task force, which recommended a 20 percent reduction in cost, concluded that a significant contributor to the high cost of FFTF equipment was the extensive use of reactor standards and that this experience influenced the CRBR project equipment cost estimate. The project participants reduced the proposed savings to 8 percent. The basis for the reduction to 8 percent was not included in the report. Further, the 8 percent

reduction was applied to all equipment items for the project.

We recognize that the prudent application of reactor standards could result in lower project costs. We believe, however, that the amount of the proposed reduction should result from an analysis of the application of the standards on CRBR equipment items or on a statistically selected sample of items which would indicate the applicability of the reduction to the entire equipment cost category.

A cost reduction of $9 million was also made for the construction estimate because it was decided to delete reactor standards for the construction cost category. This adjustment, which was initially based on a review of equipment classes, was later, at least in part, associated to individual line items.

System simplification (elimination of system components)--Westinghouse reduced the reactor manufacturers' equipment cost estimates by 7.25 percent on the basis of system simplification. This technique reduced the estimated costs by $20 million. This percentage was about midpoint in the range of cost reductions Westinghouse had experienced for complex technical programs judged similar to the CRBR. Their experience on these programs indicated that a 5 to 10 percent reduction could be achieved through system simplification.

Westinghouse tested the theory of system simplification on 43 of the 1,265 items of equipment for the CRBR and determined that such a procedure could reduce costs. These 43 items were not selected on a statistical basis. Westinghouse and another manufacturer agreed that a 10 percent reduction could result from system simplification application to all the equipment items for the CRBR. Another manufacturer disagreed, however, and informed Westinghouse that such a reduction for its part of the project was not realistic. As a result, the percent was reduced from 10 to 7.25 and applied to the entire equipment cost category. The application of 7.25 percent to the entire cost category has the same approximate effect of applying 10 percent to all equipment items except those objected to by one manufacturer. The one manufacturer indicated, however, that system simplification would be reflected in its estimate only when it was sufficiently apparent that such reductions would actually occur.

We recognize that some reductions in costs can be effected through system simplification. The amount

of such reductions, however, must be determined on an item-by-item basis or on the basis of a valid statistical sample, before the amount of the proposed reduction is applied to the entire cost estimate.

Lowering statistical probability of financial success--In reviewing the June 1974 cost estimate, project participants decided that the probability of financial success for the project should be 80 percent for reactor manufacturer equipment and 50 percent for engineering base costs. Applying statistical techniques to estimated base costs, using these probabilities, resulted in a reduction of $9 million and $43 million. The revised figures mean that, within certain parameters, project participants are 80 and 50 percent sure that the actual base costs will not exceed estimated base costs for these two categories.

Project participants estimated that with reactor manufacturer equipment and engineering contingency costs the total estimated cost should have a 90 percent probability of not being exceeded. A reduction of reactor manufacturer equipment and engineering contingency costs of about $56 million and $14 million, respectively, resulted from applying these statistical techniques.

For the August construction cost estimate, project participants proposed a 25 percent contingency allowance which amounted to $53 million, or a $40 million reduction from the June estimate. The architect-engineer stated that this reduction was made on the basis that the specific contingencies added by the project participants on portions of the estimate could be reduced and still provide a sum of contingencies which would be acceptable for the overall project.

Other plant investment, development, and operating costs

Other plant investment, development, and operating costs of $274 million represented about 19 percent of the total August cost estimate. The cost estimates constituting that category are presented below.

Cost element	1974 preliminary	
	June estimate	August estimate
	---(000,000 omitted)---	
Base costs:		
Core fabrication	$ 94	$ 75
Operation and maintenance	49	49
Special nuclear material	18	10

Project Management Corporation staff and services		$ 47		$ 32
Equipment development		120		88
Insurance		4		5
Safety-related design changes		---		11
Revenue		-47		-47
		$285		$223
Contingency:				
Core fabrication	$23		$17	
Equipment development	25		5	
Safety-related design changes	--		1	
Safety fallback design changes	--	48	28	51
Total		$333		$274

Items in the other plant investment, development, and operating cost category were reevaluated and several changes were made. The estimated costs of such items as core fabrication, staff and services, and special nuclear material were reduced on the basis of management judgment. Equipment research and development costs, which had increased after a review of the corrected June 1974 estimate, were reevaluated and certain development efforts were deleted in the August estimate. Also, certain safety-related design changes were included in the project cost for the first time and consequently showed as an increase in this cost category.

A detailed explanation of the methodology used to compile the August estimates for these cost elements is included in appendix III.

SEPTEMBER 1974 COST ESTIMATE

In September another revision to the project cost estimate was presented to the project steering committee. A comparison of the June, August, and September estimates is shown below.

	1974 estimates		
	June	August	September
	(000,000 omitted)		
Base cost	$1,194	$1,013	$1,013
Contingency	259	[a]141	[a]225
Escalation	612	325	498
Total	$2,065	$1,479	$1,736

[a]These amounts included about $29 million for safety design changes which were not included in the June estimate.

ERDA said no adjustments were made to the August 1974 preliminary base cost estimate and that the only adjustments were increases in contingency and escalation. The contingency increase was based principally on the ERDA internal cost review team's evaluation of the August preliminary estimate. Base cost increases totaling about $41 million were recommended in equipment and construction costs. The review team also recommended an increase in contingency totaling about $42 million. According to ERDA, project participants accepted the recommendations but decided that all the increases should be identified as contingency estimate increases.

The September contingency estimate of $225 million also included an estimate of $29 million for safety fallback and other safety design changes which were not included in the June preliminary estimates. Excluding this item, the September contingency estimate was about 20 percent of base cost, or about 2 percent less than the corrected June preliminary estimate.

Escalation included in the September cost estimate was based on an average annual rate of 8 percent. According to ERDA, an average annual rate of 8 percent was used in the September estimate on the basis of economic trend projection and information provided by the ERDA internal review team. The difference between the June and the September escalation costs was the reduction in base cost and contingency, since the same escalation rate was applied.

The difference of $181 million between the June preliminary base cost estimate of $1.194 billion and the August preliminary and September estimate of $1.013 billion was due primarily to

--the management decisions (see pp. 17 to 19) aimed at reducing equipment, engineering, and construction base cost estimates;

--the component research and development reductions (see p. 42);

--a decrease in fuel fabrication costs (see p. 41);

--a decrease in special nuclear fuel costs (see p. 41); and

--the addition of safety design in the August base cost estimate (see p. 42).

ESCALATION

The CRBR cost estimate is sensitive to escalation. Escalation, which is another term for inflation, is a long

term persistent rise in the general level of prices.

The following table shows the escalation cost and rates used in preparing the CRBR estimates.

1974 Estimates	Escalation Cost (000,000 omitted)	Escalation Rate (Percent)
June	$612	8
August	324	[a]8 and 5-1/2
September	498	8

[a]8 percent used for fiscal year 1975 and 5-1/2 used in other years.

Depending on the rate of escalation, the cost to construct and operate CRBR could be more or less than the current estimate of $1.7 billion. The following table shows the effect varying escalation rates would have on the September cost estimate of $1.736 million.

Escalation cost (note a)

Rate of inflation (percent)	Escalation's impact on cost estimate -(000,000 omitted)-
6	-138
8	--
10	152

[a]Calculations are based on an unescalated project cost of $1.2 billion and a cash flow prepared by PMC for the September cost estimate.

ERDA selected an 8 percent rate, after management review and evaluation, because it was considered reasonable and consistent with projections and economic indexes from various engineering and construction organizations and publications and it was considered consistent with present national economic goals concerning inflation.

An ERDA internal review team, after comparing the rates expected by eight ERDA contractors, reported that, for the near term, the 8 percent rate may be low in relation to recent economic trends.

The following table summarizes what the eight contractors expected for the years 1974 through 1976.

Year	Contractor expectations of escalation	
	Material range (percent)	Labor range (percent)
1974	12 to 38	8 to 15
1975	8 to 25	8 to 15
1976	8 to 15	8 to 15

Predicting cost trends and escalation rates is difficult and uncertain. While developing the June preliminary estimate, project participants noted that history indicated certain materials were escalating faster than were equipment or engineering labor. Also, construction labor had a high escalation rate that was expected to continue in the short term.

A changing escalation rate for construction material and labor was assumed for the June estimate. These rates varied from 10 percent for 1974 to 6 percent for 1982, with an overall rate averaging 8 percent.

Data compiled by the architect-engineer as of March 1975 indicated that the rate of increase for the labor crafts in Roane County, Tennessee (location of the project), would be about 7 percent for the year ending July 1975. Therefore the average annual rate of 8 percent applied to construction labor would seem reasonable.

Project participants also estimated that, by the end of the 5-year demonstration period, CRBR would have generated $112 million worth of electricity, of which $65 million would be attributed to escalation at 8 percent.

The 8 percent average annual rate for revenue escalation was used to be consistent with the rate used in escalating cost. This rate, however, was higher than the rates recommended by TVA and Commonwealth Edison at the time the June estimate was developed. TVA, which would pay for the electricity, recommended a 4 percent rate and Commonwealth Edison recommended a 5.5 percent rate.

The revenue escalation rate will have a bearing on project costs. If the rate of inflation for revenue is less than 8 percent, net operating costs (cost less revenue) for the project will increase; if greater than 8 percent, the costs will decrease. The following table shows the effect of varying escalation rates on net operating costs.

Rate of inflation (percent)	Impact on net operating costs (000,000 omitted)
4	$ 39
6	22
8	--
10	-26

CONCLUSIONS

We were not able to determine whether the project could be constructed and operated for $2.1, $1.5, or $1.7 billion because

--the project, at the time of estimating, was in an early design stage;

--the project is a first-of-a-kind project and sufficient and useful data was not always available to develop firm estimates;

--professional engineering judgment was a prime factor in estimating project costs;

--cost escalation for a long-term project is very speculative; and

--failure to meet the schedule could increase cost.

The methodology used to develop the June preliminary estimates was, in our view, a reasonable approach to estimating costs for a project in the early stages of development. Although certain assumptions were made and professional engineering judgment was a prime factor in compiling the estimate, a detailed approach was followed.

The August preliminary estimate resulted from a management effort to confirm the adequacy of the design and reasonableness of the cost estimate. The project estimate was adjusted downward on the basis that the actual costs could be reduced by applying certain management techniques. The September estimate was essentially the August estimate with suggested base cost adjustments included as contingency and a less optimistic view of contingency and escalation.

Because the methodology used in compiling the June preliminary estimates was not always followed in later revisions, project participants were, in effect, assuming what the project would cost if certain management techniques were successful. This procedure seems more speculative than estimating individual tasks. Therefore, we believe the September

estimate was not as refined as it could have been had the methodology used in the June preliminary estimates been followed.

We emphasize, however, that the total estimated cost to construct and operate CRBR, as in any project of this size, may change as early designs are finalized and actual cost escalation is experienced.

CHAPTER 3

CRBR SCHEDULE ESTIMATE

CRBR is scheduled to achieve initial criticality by July 1982 with commercial operation (electrical power generated and sold to a utility) scheduled to start in early 1983. CRBR has already been delayed about 3 years and has caused delays in the overall LMFBR program. Project participants established milestones for the completion of various aspects of the project which were intended to measure the project's progress.

The project schedule was prepared by the architect-engineer in considerable depth and detail. Each item to be procured and installed was integrated with the major elements of design, procurement, and construction. A detailed estimate was made of the quantities to be installed in each system and building and a detailed installation sequence was prepared. The project schedule was influenced by anticipated manpower availability, delivery times for major components of the project, the schedules for light-water reactor plants and the FFTF project, and the professional engineering judgment of the architect-engineer and other project participants. (See app. IV.)

The project schedule includes a "critical path" for the achievement of major milestones for the project. Major slippages in achieving these milestones could affect the timely completion of the project. As slippages occur, the project participants must reassess the project schedule to determine if adjustments need to be made to minimize the impact of the slippages on the project. Some provisions have been considered in making up the project schedule which would help minimize the impact of delays. For example, the schedule is predicated on utilizing one work shift. If necessary, overtime can be authorized to make up time. About $12 million has been included in the project cost estimate as a contingency for the use of overtime. In addition, the installation rates for some items of equipment can be increased through an adjustment to the present schedule.

ERDA estimated that failure to maintain the planned project schedule could increase project costs by $10 to $15 million for each month of delay. The amount of the increased cost resulting from schedule slippage depends on when the slippage occurs. Slippage in the early stages of the project could cause increases from $10 to $15 million; as the project progresses, the increase will be less.

Project participants identified several potential problem areas which could affect the schedule. Although not all these potential problems are on the critical path, some

schedule delay is possible.

TIMELY AND ADEQUATE FUNDING

When the project schedule was prepared, ERDA anticipated that congressional authorization for additional funds to purchase long lead material and major project components would be obtained by January 1975. On March 10, 1975, ERDA requested funding authorization from the Joint Committee on Atomic Energy for $181,500,000 for fiscal year 1976 and the 3 month transition period. ERDA plans to use these funds to purchase the necessary long-leadtime material and major components. However, the project participants and some officials of the ERDA Division of Reactor Research and Development believe that the authorization request is about $40 million less than the amount needed to assure that the project schedule is maintained.

The director of this division and other ERDA officials in overview positions told us that these comments do not represent an official ERDA position.

DELAYS IN LICENSING PROCESS

One CRBR project objective is to demonstrate that breeder reactor powerplants are licensable. Accordingly, NRC's licensing review is a key factor in the project schedule. Two important project milestones are (1) obtaining a limited work authorization by September 1, 1975, and (2) obtaining a construction permit by August 1, 1976.

A limited work authorization allows the applicant to prepare the project site for construction work while NRC completes its review of the construction permit application. Major construction work, however, cannot begin until the permit is issued.

Delays have already occurred in the licensing process. According to ERDA, neither the limited work authorization milestone nor the construction permit milestone will be met. A delay of 4 months is expected in each category. Since the limited work authorization is on the critical path for completion of the project, its delay could slip commercial operations beyond early 1983.

The application for a limited work authorization was submitted to NRC in October 1974. NRC, however, has not formally accepted the application for docketing because it feels additional information is necessary before a complete review of the application is possible. A formal and complete review, expected to take about 11 months, cannot begin until the application is docketed. NRC is, however, reviewing those

sections of the application which are complete.

It is also possible for the licensing process to stretch out even further. Of the 11 months scheduled for review of the limited work authorization application, 4 months have been scheduled for public hearings on the basis of past experience. Since pursuance of the breeder reactor concept is controversial and organized opposition already exists, the 4 months scheduled by the participants for hearings might not be enough. According to NRC, certain events could lengthen the hearing period. First, possible litigation could occur over the acceptability of NRC's guidelines for allowable accidental exposures to plutonium--the breeder's radioactive fuel. Secondly, the CRBR hearings could be used as a forum for challenging the need for the breeder reactor program and for CRBR. NRC believes that such intervention could extend the hearings significantly.

TIMELY DELIVERY OF LONG-LEADTIME MATERIAL AND COMPONENTS

According to ERDA and PMC, there was uncertainty in the timely delivery of long-leadtime materials and components. In the spring of 1974, the delivery time for certain materials was 16 to 57 weeks longer than delivery time was 6 months earlier. There is also a limited number of suppliers for certain CRBR major components.

In March 1975 project participants said economic conditions had changed and this was no longer a problem. Delivery times have improved and the number of avilable suppliers has increased. This is one area of the project, however, that is subject to changes in economic conditions. As the project progresses and economic conditions change, there could be problems again. The project schedule, however, has allowed for some slippage in this area.

ERDA can use the Defense material system priority rating to direct manufacturers and suppliers to fabricate and deliver needed material and components ahead of private industries' needs. ERDA has already used the priority rating to obtain steel forgings and may have to use it to insure timely delivery of other items. In addition, there is a limited number of suppliers for such CRBR components as a turbine generator and a reactor pressure vessel.

Problems in procuring the turbine generator

The turbine generator is a major component of the CRBR plant. The project schedule called for ordering the generator in September 1974. A contract for the turbine generator was let on March 31, 1975. Project participants believe that

the project schedule will not be delayed because of the slippage in letting this contract.

While procurement of the turbine generator does not seem to be a problem on the project at this time, the circumstances discussed below are indicative of the problems which the project participants must overcome to successfully complete the CRBR project.

Only two companies in the United States supply turbine generators for nuclear powerplants. Early in 1974 PMC solicited proposals for the design and fabrication of a generator. Both companies submitted proposals but took exception to a contract clause which would allow the Comptroller General to examine company records.

PMC began negotiations with the vendor with the most favorable cost and technical acceptance proposal. On August 9, 1974, PMC informed ERDA and other project participants that the vendor refused to accept the access-to-records clause. On August 30, 1974, PMC entered into a letter of intent agreement with the vendor because an agreement could not be reached on all terms and conditions of the contract.

The letter of intent was to be null and void if a contract was not signed by January 1, 1975. The vendor also told PMC that the price of the generator would increase by about $1.5 million if a contract was not signed by the expiration of the letter of intent. The expiration date was extended to April 1, 1975, without any increase in the contract price.

Problems in procuring the reactor pressure vessel

The reactor pressure vessel is another major component of CRBR and is one of the critical items in meeting project schedule milestones. The project schedule called for ordering the vessel by October 1, 1974, with delivery by June 1979. Failure to get timely delivery of the pressure vessel could delay the project.

Project participants are facing problems in procuring this component since only three manufacturers in the United States have the capability to build the pressure vessel. One of these manufacturers furnished a similar pressure vessel for FFTF.

In May 1974 proposals were requested for the fabrication of the pressure vessel. Only the manufacturer that furnished the vessel for FFTF responded but, because its fabricating capacity was already fully employed, it could not insure

delivery of the vessel until January 1980--6 months later than the project schedule called for. The manufacturer also proposed that the Federal Government furnish manufacturing facilities. The value of such facilities would be $15 to $20 million.

ERDA did not accept the terms of the proposal and indicated at that time that it would use the Defense material system priority rating for this component. Based on ERDA's analysis of the manufacturer's workload, the use of the priority rating would not critically delay the fabrication of commercial reactor pressure vessels.

On March 12, 1975, Westinghouse officials said the situation has changed. Another experienced supplier has documented his intention to bid and deliver the vessel by the required date. Therefore, there will be bidding competition and neither of the bidders will require Government-furnished facilities. Also it will not be necessary to use a priority rating.

UNAVAILABILITY OF CRAFTSMEN

The unavailability of craftsmen qualified to build the CRBR, particularly welders, could affect the timely completion of the project.

TVA has experienced difficulty in obtaining enough construction personnel to build a light-water reactor. In November 1974 TVA informed NRC that there had been a 4-month slippage in completing a nuclear powerplant because of a shortage of qualified steamfitters and welders.

During the period 1975-82, construction activity will occur at 14 nuclear powerplant units and a fuel reprocessing plant within a 150-mile radius of the Clinch River site. TVA has projected that an additional 700 welders will be needed in the next 4 years for the planned construction.

The unavailability of craftsmen is not a problem unique to the area near the CRBR site. Of the 69 nuclear powerplants under construction as of August 23, 1974, 11 had incurred schedule delays because of the unavailability of craftsmen.

The potential problem of getting craftsmen was recognized by project participants when developing the preliminary cost estimate. Estimates for training programs have been included in the cost estimate.

MAJOR DESIGN CHANGES

At the time of our review, several of the design features of CRBR were conceptual and several design decisions had not been made. Also, NRC differs with the project participants on one major safety issue--whether the plant will be designed to acceptably accommodate the consequences of a major core disruptive accident[1]--which must be resolved before NRC issues a construction permit.

The schedule for completing engineering design and procurement contains a small allowance for changes as a result of the licensing review process. According to ERDA, this allowance might not be enough because of the highly developmental nature of the plant and because of possible differing opinions on incorporating certain design features.

Core catcher uncertainty

A currently unresolved safety issue is whether CRBR will be designed to acceptably accommodate the consequences of a major core disruptive accident. The project participants believe that a core disruptive accident, which could lead to the release of massive amounts of radioactivity to the environment, is so highly unlikely that it need not be a design basis accident[2]. However, NRC believes that core disruptive accidents, although unlikely, are within the realm of possibility and should be provided for in the CRBR design, until the probability and consequences of such accidents are better understood. This may require additional safety features, such as an ex-vessel core catcher[3]. Therefore, parallel work has been started on a CRBR design that includes an ex-vessel core catcher, even though project participants believe this and other additional safety features are not needed. NRC officials have pointed out that their review of the CRBR construction permit application and additional research and development information might indicate that the CRBR design is adequate without additional safety provisions.

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[1] A core disruptive accident causes structural failure of a core (central portion of the reactor containing the nuclear fuel).

[2] Design basis accidents are hypothetical accidents selected as a basis for the design and incorporation in the plant features and equipment required for protection of public health and safety.

[3] A ex-vessel core catcher is a device located below and outside of the reactor vessel which, in the event of a core disruptive accident, will retain the core debris.

The estimated cost of fabricating and including a core catcher in CRBR is $20 million. A core catcher is conceptual and has never been installed in nuclear reactor plants.

In August 1974 a project participant said a schedule delay of 1 to 2 years could result if a core catcher has to be included in CRBR. Since then, project participants have proceeded with a parallel design effort to include an ex-vessel core catcher in the CRBR plant. In March 1975 project participants said the schedule would be maintained through intensive design efforts.

CONCLUSIONS

The project schedule was prepared in considerable depth and detail. Some potential problems in the schedules were recognized by the project participants and, to the degree possible, provided for in the schedule. As slippages occur, the project participants will have to reassess the schedule to determine what adjustments, if any, need to be made to minimize the impact of the slippage on the project. Rescheduling of the project might increase project costs through extension of the planned completion date or through increased labor or material costs. Also, failure to achieve the schedule could delay the overall LMFBR program.

CHAPTER 4

SCOPE OF REVIEW

We reviewed the 1974 cost and schedule estimates, evaluated the methodology used in arriving at these estimates, and identified problems or uncertainties which could impact on completing the project.

At the time we started our review, ERDA was scheduled to officially approve a cost and schedule estimate that had taken about 6 months to prepare. Because the preliminary estimate changed greatly, we had to evaluate not only the estimate prepared at that time but also the several changes that followed.

We made our review at ERDA's offices in Germantown, Maryland; NRC's offices in Bethesda, Maryland; and the demonstration project office in Chicago, Illinois. We met with representatives of PMC, Breeder Reactor Corporation, Burns & Roe, Inc., and the three reactor manufacturers involved in developing the CRBR estimate. We examined pertinent documents, records, reports, and files relating to the cost and schedule estimates at these organizations.

METHODOLOGY USED IN DEVELOPING JUNE 1974 PRELIMINARY ESTIMATES FOR EQUIPMENT, ENGINEERING, AND CONSTRUCTION COSTS

Following are examples showing the methods used by project participants to develop equipment, engineering, and construction item estimates for the June 1974 preliminary CRBR project cost estimate.

EQUIPMENT ESTIMATE

Fuel-handling cell--A facility where spent fuel is removed from the reactor and prepared for disposal and where new fuel is prepared for use in the reactor--estimated cost $766,000, including $12,000 for shipping. The cost estimate was based on a contract price of $742,000 for a similar component of FFTF, adjusted upward by $12,000 to reflect the more complicated nature of the CRBR project plus the cost for shipping. The adjustment was based on the estimator's judgment of what would be needed for the CRBR project.

Fire-suppress grating--Grating needed for suppressing fire--estimated cost $320,000. The cost estimate was for about 72,000 square feet of grating. The exact thickness and gauge of grating needed was unknown at the time the estimate was prepared because weight and stress requirements were not defined. The estimator selected a price from a vendor's catalog for what he believed to be the probable grating.

Core restraint--Structural hardware used to support the core assemblies and restrict the movement of fuel away from the core center line as power increases--estimated cost $4,045,000. The estimate included $3,840,000 for fabrication, $113,000 for vendor engineering, and $92,000 for shipping. The fabrication cost was an engineering estimate based on FFTF experience and modified for such things as design changes and quantity and size differences for the CRBR project. The vendor engineering cost estimate was based on a combination of FFTF experience and the relationship of engineering and fabrication costs for other nuclear projects. The shipping cost estimate was based on FFTF experience.

Reactor vessel and support--A cylindrical shaped container used to hold the reactor core and its supporting structural hardware--estimated cost $10,511,000. Included in this estimate was $5,992,000 for equipment fabrication, $3,449,000 for vendor engineering, $974,000 for equipment testing, and $96,000 for shipping.

During 1973 the estimator received a vendor's proposal of $10,181,744 for a reactor vessel and $1,992,787 for a main

support. The proposal included a 25 percent profit rate. In addition, an in-house manufacturing estimate of $6,717,000 for the reactor vessel was prepared, which used a 15 percent profit rate.

In February 1974 Westinghouse redesigned the reactor vessel and the support as one component. The fabrication estimate was computed by using the in-house estimate of $6,717,000 for the reactor vessel and the vendor's proposal for the main support, adjusted for a lesser profit rate or $1,534,000. This total fabrication cost estimate of $8,251,000 was then adjusted downward for an estimated fabrication cost saving resulting from redesigning both components as a single component. The cost-saving adjustment was based on actual FFTF cost experience, vendor estimates, and in-house engineering estimates.

The engineering cost estimate was an average of the vendor's proposal of $3,905,415 and an in-house estimate of $2,970,180. The equipment testing and shipping cost estimates were developed by obtaining the actual FFTF cost and prorating it to the components on the basis of fabrication dollars.

ENGINEERING ESTIMATE

Head access area--An opening providing access to the head of the reactor enclosure--estimated cost $3,146,000. The engineer who prepared the estimate for designing the head access area explained that his estimate of labor hours was based on his engineering judgment and on data obtained through discussions with an FFTF engineer and a review of his records.

His discussion with the FFTF engineer concerned experience gained and problems encountered on that project and his advice on those improvements that could be made. Similar comments received from other engineers showed that judgment and prior experience were the common bases for estimating.

CONSTRUCTION ESTIMATE

Reactor vessel and support, closure head, and guard vessel (enclosure system)--The primary structure and service equipment which encloses the reactor--estimated installation cost $3,030,000. Each of these line items was included separately in the cost estimate. The total cost for all three items was based on actual and projected FFTF installation cost. The total cost was then prorated to each of the three items on the basis of fabrication dollars.

Cooling tower--A system to cool plant water used in generating electricity--estimated installation labor cost $714,000.

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Installation labor was estimated by applying an installation rate of 40 percent to equipment cost. The rate was developed using historical data, experience in labor productivity in the Tennessee area, engineering publications and handbooks, vendor consultation, and industry standards.

Structural hardware and embediments--Supports for the plant's sodium piping system--estimated cost $1,755,000. The cost estimate was based on the estimator's experience and judgment that material and installation cost for structural hardware and embediments would be about $150 per linear foot of piping.

METHODOLOGY USED IN DEVELOPING JUNE 1974 PRELIMINARY ESTIMATES FOR OTHER PLANT INVESTMENT, DEVELOPMENT, AND OPERATING COSTS

The following sections discuss the methodology used by project participants in developing other plant investment, development, and operating costs for the June 1974 preliminary CRBR project cost estimate.

CORE FABRICATION

The June preliminary cost estimate of $117 million for core fabrication consists of $94 million for base costs and $23 million for contingency. The base cost includes $88 million for fabrication of core assemblies and a $6 million fee for a fuel procurement agent.

Westinghouse based the core fabrication costs on FFTF-type design, technology, and costs; light-water reactor fuel technology; and various assumptions. The Hanford Engineering Development Laboratory prepared the fuel procurement estimate and reviewed and commented on Westinghouse's fabrication cost estimates. The $23 million contingency was 25 percent of base costs. The percent for contingency was based on participants' judgment.

OPERATION AND MAINTENANCE

The June preliminary estimate of $53 million for operating and maintaining the plant through the end of the 5-year demonstration period included about $33 million for labor and about $20 million for material.

TVA developed the labor cost on the basis of (1) an estimated peak work force of 175 employees declining to 163 employees during the last 2 years of the demonstration period and (2) a detailed accounting of employee salaries. Staffing requirements were developed yearly on the basis of a TVA staffing plan and the operating schedule. This staffing level was compatible to staffing levels at other TVA nuclear projects. However, we noted that:

--TVA based its estimate on an operating schedule which showed criticality to be December 1, 1981, rather than July 1, 1982, as presently scheduled. According to a PMC officical, the 7-month difference in criticality dates will result in some increased escalation cost as the estimated schedule will slip by 7 months.

--Labor cost was understated by about $1 million.

According to a PMC official, the cost of training operations personnel was inadvertently excluded from the estimate.

TVA and Westinghouse developed the material estimate of $20 million. TVA prepared an operating and maintenance material cost estimate of $6 million based on its experience with fossil fuel plants and light-water reactors. To this, Westinghouse added $14 million for the cost of shield assemblies and control assemblies, which were expected to be replaced during the demonstration period.

As a result of an ERDA internal review team review, the estimate was reduced by $4 million to a revised estimate of $49 million. This reduction was made on the basis that shield assemblies would not have to be replaced during the operating period.

PMC STAFF AND SERVICES

The June 1974 preliminary estimate of $47 million for PMC included $40 million for staff and office expenses and $7 million for purchased services.

The estimate for staff and office expenses represented the summation of PMC's (1) actual cost through fiscal year 1973, (2) fiscal years 1974 and 1975 budgets, and (3) estimated cost of staff through fiscal year 1987.

PMC estimated an annual 775 staff-year staffing requirement through fiscal year 1987 to meet the project schedule.

The $7 million for purchased services includes estimates for special site and environmental studies; preparation of environmental reports; audits; management consultants; and fees. These estimates were based on judgment and fee schedules. Except for licensing fees, the estimates appear reasonable. Licensing fees were understated by about $770,000 because old fee schedules were used and certain licensing fees were excluded from the estimate.

PMC was not consistent in calculating operating costs and revenue. The estimate did not include staff and service expenses for a 7-month operational test period preceding the 5-year demonstration period; however, revenues earned during this period were included in the estimate.

EQUIPMENT DEVELOPMENT

The June 1974 preliminary cost estimate included $9 million for certain costs associated with base technology

programs under the direction of the reactor manufacturers. Interpretations of what base technology projects were properly chargeable as costs of the CRBR project were revised and the estimate was adjusted.

After the June estimate, the ERDA internal review team noted additional ERDA equipment development activities which should have been included in the estimate. ERDA's Division of Reactor Research and Development estimated these additional development activities (such as prototype design, fabrication, tests, and development of equipment) at about $165 million, excluding contingency. Westinghouse and ERDA reduced this estimate to about $120 million, excluding contingency because they determined that the cost of some of these activities was not appropriately chargeable to the CRBR program. A contingency of $25 million was added to arrive at the corrected June estimate of $145 million.

INSURANCE

The June preliminary cost estimate includes $4 million for nuclear insurance, covering the period January 1982 through July 1987. This estimate was developed by averaging insurance estimates provided by Commonwealth Edison, TVA, ERDA, and a commercial insurance broker.

The estimate includes commercial coverage (up to $110 million) and Government indemnity (over $100 million and up to $560 million). The Government indemnity coverage, established by section 170 of the Atomic Energy Act of 1954, as amended, is commonly referred to as the Price-Anderson Indemnification Act. The President recently vetoed a measure to extend this provision, which is scheduled to expire in August 1977. The project will be eligible for this indemnification providing a construction permit is granted before August 1977. If a permit is not granted and the Price-Anderson legislation is not extended, the possibility exists for increased insurance payments. According to the project schedule, a construction permit is expected to be issued by August 1976.

REVENUE

The June preliminary cost estimate includes a $47 million credit for revenue from the sale of electricity through the end of the demonstration period. PMC developed this estimate assuming the plant would generate 350 megawatts of electricity for 27,375 hours. A PMC official said these hours were based on the historical experience of two light-

water reactors and an assumed 75 percent capacity[1] during the last 2 years of the demonstration period.

[1]Capacity refers to the amount of electricity produced as a percentage of the amount which could have been produced had the plant operated at full capacity throughout the reporting period.

METHODOLOGY USED IN DEVELOPING AUGUST 1974 PRELIMINARY ESTIMATES FOR OTHER PLANT INVESTMENT, DEVELOPMENT, AND OPERATING COSTS

The following sections discuss the reasons for increases and decreases from the June 1974 to the August 1974 preliminary CRBR project cost estimates for other plant investment, development, and operating cots.

CORE FABRICATION

The cost estimate for core fabrication decreased from $117 million to $92 million when the estimate was revised in August. Although the June base estimate of $36 million for fabricating initial core assemblies remained unchanged, the $52 million for fabricating reload core assemblies dropped to $39 million, because it was decided that fewer reload assemblies would be needed and because the $6 million fee for a fuel procurement agent was eliminated. Because of decreases in the base cost and contingency rate, the amount for contingency dropped from $23 million to $17 million.

PMC STAFF AND SERVICES

The August preliminary cost estimate of $32 million for PMC included about $25 million for staff and office expenses and about $7 million for purchased services. This represented a net reduction of $15 million.

The major change was reducing the staff and office expense estimate. In computing staff cost for the August proposal, PMC assumed it would receive 200 staff-years of professional services from the utilities without charge and did not include the cost of these services. A PMC official said PMC had no commitment from the utilities that the utilities would supply these free services. As of November 1974, only 5 free people were on board versus the 10 planned for the entire 1975 fiscal year. Of these five, only one was from a utility, the rest were from industry. If PMC does not obtain the expected 200 staff-years of free services, staff costs are likely to increase.

SPECIAL NUCLEAR MATERIAL

The August preliminary cost estimate included $10 million for special nuclear material. This represented an $8 million reduction which resulted from a management decision to use a nuclear fuel identical to that used in FFTF, rather than to recycle fuel from light-water reactor plants.

EQUIPMENT DEVELOPMENT

The August preliminary cost estimate included $93 million for equipment development. This represented a $52 million decrease in the June estimate. Of this decrease, $32 million was in base cost and $20 million was in contingency.

In August 1974 Westinghouse reviewed the criteria for determining what ERDA programs should be applied to base technology and charged to the CRBR project. It was determined that a reduction of $26 million should be made. Westinghouse's rationale for the reduction was that those activities which were an "integral part of the long-range LMFBR program leading to the development of a commercial LMFBR" nuclear powerplant should not be charged to the CRBR program. Westinghouse also said an additional $6 million could be reduced from the estimate by deleting certain programs not required by reactor manufacturers to design CRBR. As a result, the August estimate of $93 million included $88 million for the base cost and $5 million for contingency.

SAFETY-RELATED DESIGN CHANGES

In August 1974 Westinghouse included $11 million in baseline cost and $1 million in contingency cost for safety-related design changes that were identified after the June estimate. These changes were for containing core accidents and removing decay heat.

SAFETY FALLBACK DESIGN CHANGES

In August 1974 Westinghouse estimated $28 million for safety features which might be required for the project. These safety features included (1) adding an ex-vessel core catcher, (2) limiting the escape of coolant from reactor vessel pipes, and (3) enclosing the head access area.

The largest portion of the cost estimate is providing an ex-vessel core catcher for $20 million. This is for designing and constructing a capability within the plant that would terminate a core meltdown. Currently, this feature has not been designed; however, a design similar to the one developed in FFTF studies was used as the basis for cost estimating.

MAJOR CRBR PROJECT MILESTONES

Submit application for limited work authorization	Oct. 1, 1974
Submit preliminary safety analysis report	Dec. 1, 1974
Receive limited work authorization	Sept. 1, 1975
Receive construction permit	Aug. 1, 1976
Start foundation for CRBR	Jan. 1, 1977
Complete reactor containment building	Jan. 1, 1979
Set reactor vessel	July 1, 1979
Submit final safety analysis report	Feb. 1, 1980
Begin testing sodium systems	Sept. 1, 1981
Receive operating license	Apr. 1, 1982
Achieve initial criticality	July 1, 1982

PRINCIPAL OFFICIALS RESPONSIBLE FOR ADMINISTERING THE ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
ATOMIC ENERGY COMMISSION		
Chairman:		
Dixy Lee Ray	Feb. 1973	Jan. 1975
James R. Schlesinger	Aug. 1971	Feb. 1973
Glenn T. Seaborg	Mar. 1961	Aug. 1971
General Manager:		
Robert D. Thorne (acting)	Jan. 1975	Jan. 1975
John A. Erlewine	Jan. 1974	Dec. 1974
Robert E. Hollingsworth	Aug. 1964	Jan. 1974
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION		
Administrator:		
Robert C. Seamans, Jr.	Jan. 1975	Present
Assistant Administrator for Nuclear Energy:		
Robert D. Thorne (acting deputy)	Jan. 1975	Present

APPENDIX VI

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

APR 2 [illegible]

Mr. Henry Eschwege, Director
Resources and Economic
Development Division
Room 6146
U.S. General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Eschwege:

It is important for the Congress to be well informed about the Liquid Metal Fast Breeder Reactor (LMFBR) program, including the Clinch River Breeder Reactor (CRBR) project. ERDA and the other CRBR participants have cooperated fully with GAO so that the report on CRBR cost and schedule estimates could be as informative as possible. Although the report is factually correct, we believe it could be significantly enhanced if some basic information was presented more clearly to help provide a more complete understanding. We would like to see the following points included in the report, preferably included in or clearly referenced in the digest so they can be considered while initial opinions are being formed.

The report does not directly recognize ERDA's responsibility for assuring that plans are sound, that all known factors have been considered, and that costs are held to the lowest feasible level. Consistency in methodology is important, but should not preclude special attention to program elements or assumptions that should be reconsidered from a different point of view. Managements' perspective of a total project frequently differs from that of the various individual participants, and there are often valid reasons for adjusting estimates at a summary level to recognize management judgments.

For a large complex project such as the CRBR, several planning and review iterations will normally be required to develop a firm estimate. In developing the 1974 CRBR estimate, represented by the September column in this report, ERDA went through four stages of development; the first was the original formulation by the lead contractors and the second was to adjust for errors and omissions identified during contractor(s)/utility/government reviews. The next iteration was based on a comprehensive

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Mr. Henry Eschwege

reevaluation by the contractors involved; it incorporated design and scope changes which affected the base costs and assumptions related to contingency and escalation were revised. The final revisions were based on more conservative estimates by the Government for contingency and escalation.

The methodology used for the overall estimating process is what is significant; data resulting from different cycles should not ordinarily be analyzed in the same fashion that would be appropriate for a series of discrete firm estimates. While the methodology for each cycle leading up to the 1974 CRBR estimate was not precisely the same, it is considered to be reasonably consistent both in total and from cycle to cycle.

The report indicates that the approach and methodology used for the June preliminary estimates is reasonable but, because of differences in methodology, the results of subsequent cycles are considered to be more speculative. Further, the report fails to emphasize the fact that all the project participants involved disagree with the contention that the refinement process produced a more speculative result. By overemphasizing the significance of analytic comparisons between different cycles of the estimating process and the mechanics of some of the interim calculations, the report makes it difficult to determine the magnitude or significance of any real difference of opinion. For a clearer understanding the differences between the June and September amounts should be examined.

(Millions)

	June Revised Preliminary	September 1974 Estimate	Difference
Base Cost	$1194	$1013	$(181)
Contingency	259	225	(34)
Escalation	612	498	(114)
Total	$2065	$1736	$(329)

Mr. Henry Eschwege

Since the same rate is used for escalation in both cases, the entire difference in amount results from differences in other parts of the estimates. Although contingency is $34 million less in the September estimate, the percentage relationship to base cost is the same as in the earlier estimate. The basic differences between the June and September versions of the CRBR estimate result from differences in the estimates for base cost. As the report recognizes, slightly more than half of the change ($91 of $181 million) was developed by detailed review and analysis of information included in the June preliminary estimate. An additional 29% ($52 million) resulted from revising assumptions related to what a reasonable level of risk would be at the system level. The remaining 21% of the base cost reduction ($38 million) is almost entirely the result of assumptions related to more prudent application of RRD standards than that experienced with the FFTF and savings that should be obtainable through systems simplification. The assumptions related to application of RRD standards and those related to savings from systems simplification were based to a great extent on the experience of other projects and both were applied to the CRBR as a percentage of the reactor manufacturer's equipment estimates. The report recognizes, appropriately, the need to use a combination of professional technical judgment and experience in deriving the initial detailed estimates. The same type of professional technical judgment and experience was relied on to develop estimates for savings related to the use of RRD standards and systems simplification.

We agree with the report statement that "the total estimated cost to construct and operate the CRBR, as in any project of this size, may change again -- either higher or lower -- as early designs are finalized and actual cost escalation is experienced." However, we do not agree with any implications that $1.736 billion is not a sound base estimate. We agree that, as a result of adjusting at a less detailed level for RRD standards and systems simplification, there may be a slight increase in the likelihood that the estimate will be exceeded. Further, the resulting estimate is lower than the amount initially compiled in June, and it is a truism that the lower number has a greater chance of being exceeded by actual costs than the higher number. However, the $1.736 billion is considered by all project participants to have a probability of attainment of .9 which is quite high for a project of this type. All of the participants agree that this is the best current estimate and all believe the probability of attainment is conservative.

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In discussions with GAO representatives, RRD officials and other project participants expressed concern that costs might increase beyond present estimates if adequate and timely funding authorization is not provided, and there was some speculation as to what the amount of cost increase might be if the project schedule were to be delayed because of funding problems. The amounts discussed were contractor forecasts that have not been fully evaluated. Any representation of these discussions as a March 1975 revised estimate is misleading and does not represent ERDA policy.

Sincerely,

T. A. Nemzek, Director
Division of Reactor Research
and Development

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