OAK RIDGE NATIONAL LABORATORY
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UNION CARBIDE CORPORATION
NUCLEAR DIVISION

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37830

June 15, 1982

Mr. Argil Toalston, Acting Chief
Antitrust and Economic Analysis Branch
Division of Engineering
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Toalston:

Clinch River Breeder Reactor (CRBR) Project
B0741 -- On-Call Assistance for Power Plant Cost Studies

In accordance with your letter of May 18, 1982, requesting assistance in verifying the reasonableness of applicant's cost estimates for the Clinch River Breeder Reactor (CRBR) Project and my letter of May 28, 1982, I am providing the following information that we have developed. The approximate cost for this work is as follows:

Manpower	$3,000
Computer services	50
Travel	0
Other	0
Total	$3,050

Verification of the reasonableness of applicant's cost estimate at the existing Oak Ridge site

According to the attachment to your letter of May 18, the applicant's estimate of direct and indirect costs for construction of the plant for operation in 1989 is

Base cost (without escalation)	$1,055.8 million
Escalation @ 8%/year compound	985.4
Contingency allowance (including escalation)	153.8
Total	$2,195.0 million

The base cost is in 1974 dollars; the escalation at 8%/year is applied to annual cash flows; and the contingency allowance amounts to 7.5% of the subtotal of base cost and escalation. There is no allowance for interest on funds used during construction.

1. The CONCEPT capital investment cost computer code was used to estimate the cost for a 1200-MW(e) PWR for the Atlanta area. The total cost is $691 million in 1974 dollars for the total of the direct and indirect costs without contingency allowance and with a craft labor content of 20 million manhours. For a 400-MW(e) PWR, the CONCEPT estimate is $405 million in 1974 dollars with 11.2 million manhours. On a comparison basis, the CRBR nuclear steam supply system should be expected to cost as much or more than a 1200-MW(e) PWR since containment diameters, vessel sizes, and heat exchanger surfaces are comparable or greater, design temperatures are higher, and the CRBR is a prototype with first-of-a-kind costs for the nuclear components. On the other hand the CRBR balance of plant should cost no more than similar equipment for a conventional plant of equivalent electric output.

2. The applicant has developed all costs in 1974 dollars and then escalated the annual cash flows at 8%/year to obtain total costs. The 8%/year escalation rate is low for the 1974-1982 time period in comparison with the Handy-Whitman index of power plant construction costs, which has increased at 9.8%/year for nuclear plants and 10.4%/year for fossil-fired plants since 1974. It would be better practice to tabulate past costs in year-of-expenditure dollars, e.g. 1974 costs in 1974 dollars, 1975 costs in 1975 dollars, ..., and 1981 costs in 1981 dollars, since there should be an accurate accounting of these costs, and then provide projected costs in today's dollars with allowances for future escalation. A justification for the projected escalation rate should be provided, and the sensitivity of completed plant costs to the assumed escalation rates can be determined. Three sources (see Table 1) indicate that nuclear power plant construction costs have increased at a real escalation rate of 1.5-2.4%/year greater than the general inflation rate as measured by the Gross National Product Implicit Price Deflator. The applicant's 8%/year is consistent with a general inflation rate of 6%/year. Some estimates of the overall inflation rate (IPD) for the 1980s and 1990s are (1) the California Energy Commission with 8%/year in the 1980s and 6.6%/year in the 1990s,[1] (2) Blue Chip Economic Indicators with 8%/year to 1985 and 6.1%/year thereafter through 1990[2] and (3) DRI, Inc. with 8.8%/year in the 1980s and 6.0%/year in the 1990s[3]. Based on these projections it appears that 8%/year for power plant construction costs for 1982 through the completion of construction of the CRBR Project is somewhat optimistic.

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[1] California Energy Prices, Staff Report, California Energy Commission, (July 1981).

[2] Blue Chip Economic Indicators, Eggert Enterprises of Sedona, Arizona (Nov. 1981) as referenced by W. W. Brandfon in Cost Impacts of Nuclear Project Durations, Atomic Industrial Forum, Inc., Workshop on Nuclear Power Financing, Las Vegas, NV (Feb. 9, 1982).

[3] Energy Review, DRI Inc., Autumn 1981, p. 178.

Table 1. Comparison of power plant construction cost indexes 1967–1980

	Compound average annual rates (%/year)		
	Coal	Nuclear	IPD[a]
Ebasco[b]	8.7	8.9	6.4
Handy-Whitman[c]	8.5	7.9	6.4
CONCEPT[d]	8.4	8.0	6.4

[a] Gross National Product Implicit Price Deflator.

[b] Ebasco Cost/Schedule Newsletter, Issue No. 81-1, April 1, 1981.

[c] North Atlantic Region, The Handy-Whitman Index of Public Utility Construction Costs, Whitman, Requardt and Associates, 1304 Saint Paul Street, Baltimore, Maryland 21202.

[d] C. R. Hudson II, *CONCEPT-5 User's Manual*, ORNL-5470, January 1979, with cost-index data updated to July 1981.

3. Applicant's estimate of initial nonfuel operation and maintenance (O&M) costs in 1988 is $11.8 million/year in 1974 dollars. The updated OMCOST estimate is approximately $28 million/year in 1982 dollars, not including insurance costs and administrative and general expenses (see Table 2). The OMCOST estimate de-escalated to 1974 at 8%/year is approximately $15 million/year [$28 million/$(1.08)^8$ = $15 million]. The OMCOST estimate de-escalated to 1974 at 10%/year is $13 million/year. Since the CRBR is a prototype, the annual O&M costs should be no lower than for a comparable PWR, and probably higher.

4. The contingency allowance of 7.5% includes the base plant direct and indirect costs and the escalation allowance. This allows for some uncertainty in the 8%/year escalation rate and allows for normal estimating errors for a well-defined scope of supply. However, it does not adequately provide for design and regulatory evolution such as that experienced by light-water reactors during licensing and construction. A separate contingency allowance should be established for this purpose.

Verification of the reasonableness of applicant's increase in labor costs due to different labor rates at alternative sites

Our analysis of labor cost increases for the alternative sites and completion of construction in 1993 is summarized in Table 3. The alternative TVA sites, Phipps Bend, Yellow Creek, Murphy Hill, and Hartsville, are proxy sites selected to develop a range of costs applicable throughout the TVA service area.

The composite hourly rates were developed by obtaining the distribution of crafts from Attachment A to a memo dated May 28, 1982, from Richard A. Chidlow, Assistant Director for Construction, CRBR Project, to Ray Copeland, Public Safety, and from Appendix A of "A Report to the Nuclear Regulatory Commission Re/Contract NRC-03-79-125", dated March 1982, prepared by Construction Labor Demand System, Employment Standards Administration, U.S. Department of Labor. Hourly rates for the various crafts and sites were obtained from Mr. L. E. Karter of Mr. Chidlow's staff. The hourly rates were confirmed by spot-checking principal crafts with those published in "The Richardson Construction Cost Trend Reporter," Richard Engineering Services, Inc., January 1982, for cities nearest the various plant sites. The hourly rates obtained from the CRBR Project Office and from Richardson include fringe benefits, but do not include travel and subsistence allowances that may apply to remote sites. Composite hourly rates were then calculated and adjusted to 1982 basis. Increases in total manual labor costs were calculated based on a total manual labor content of 23,014,000 manhours for all sites. Costs in year-of-expenditure (YOE) dollars were calculated using 8%/year escalation rate and an approximate cash flow curve for 1993 startup.

Table 2

SUMMARY OF ANNUAL NONFUEL OPERATION AND MAINTENANCE COSTS
FOR BASE-LOAD STEAM-ELECTRIC POWER PLANTS IN 1982.0
USING OMCOST VERSION 3-29-82

PLANT TYPE IS PWR
NUMBER OF UNITS PER PLANT 1
THERMAL INPUT PER UNIT IS 1254. MWT
PLANT NET HEAT RATE 10700.
PLANT NET EFFICIENCY, PERCENT 31.89
EACH UNIT IS 400. MWE NET RATING
ANNUAL NET GENERATION, MILLION KWH 2279.
WITH BASE LOAD CAPACITY FACTOR OF 0.65

	DIRECT COSTS $1000/YEAR	
STAFF ONSITE	14826.	
(401 PERSONS AT $ 36973.)		
MAINTENANCE MATERIAL	4299.	
FIXED		3383.
VARIABLE		916.
SUPPLIES AND EXPENSES	5028.	
FIXED		4800.
VARIABLE		228.
FEES, INSPECTIONS, REVIEWS	488.	
OFFSITE SUPPORT SERVICES	3697.	
INDIRECT COSTS		
ADMINISTRATIVE AND GENERAL	14516.	
COMMERCIAL LIABILITY INS.		401.
RETROSPECTIVE PREMIUM		6.
GOVERNMENT LIABILITY INS.		8.
PROPERTY INS. (PRIMARY)		2000.
PROPERTY INS. (EXCESS)		1600.
REPLACEMENT POWER INS.		2000.
OTHER A&G		8502.

	COSTS $1000/YEAR	UNIT COSTS MILLS/KWH(e)
TOTAL FIXED DIRECTS AND INDIRECTS	41710.	18.30
TOTAL VARIABLE DIRECTS AND INDIRECTS	1144.	0.50
TOTAL ANNUAL NONFUEL O&M	42855.	18.80
TOTAL NONFUEL O&M LESS 'OTHER A&G'		15.07
TOTAL NONFUEL O&M LESS A&G		12.43

Table 3. Increases in manual labor costs at alternative sites

	Composite Hourly Rate, 1982 $/hr	Increase, 1982 $/hr	Increase, 1982 $ millions	Increase,[a,b] YOE $ millions
Oak Ridge	13.17	base	base	base
Phipps Bend	13.17	0	0	0
Yellow Creek	14.94	1.77	41	70
Murphy Hill	14.94	1.77	41	70
Hartsville	14.28	1.11	26	45
Hanford	20.32	7.15	165	282
Savannah River	15.72	2.55	59	101
Idaho	21.11	7.94	183	313

[a] For 1993 operation.

[b] Add $121 million to each value to include escalation of Oak Ridge base manual labor costs from 1989 to 1993 plant startup.

This analysis indicates that cost increases due to differences in manual hourly rates alone will range from zero to $41 million for alternative sites in the TVA service area and from $59-183 million for the other alternative sites. For 8%/year escalation rate and 1993 operation, the cost increases due to differences in manual hourly rates will range from zero to $70 million for the TVA service-area sites and $101-313 million for the other sites.

To include non-manual labor increases, we suggest increasing the manual labor increases by 25%. This results in total manual and non-manual labor increases of zero to $88 million for the TVA sites and $126-391 million for the other sites.

This analysis does not include escalation of the Oak Ridge site base labor costs for the 43-month delay, which the applicant estimates for moving the CRBR to an alternative site. We estimate this to be about $121 million for manual labor costs and about $30 million for non-manual labor costs.

Comments

The applicant's cost estimate at the existing Oak Ridge site may be low because of (1) an escalation rate that is too low and (2) inadequate contingency allowance for design and regulatory evolution during the licensing and construction process. Also, the applicant has not included an allowance for interest on funds used during construction, which, if included, will increase the estimate by several hundred million dollars.

The applicant's estimates for additional labor costs at alternative sites appear to be reasonable for the higher labor cost sites, Hanford and Idaho, although our estimates are slightly lower. This might be due to our use of an approximated cash flow curve. Our estimates are approximately $50 million lower than the applicant's estimates for the high-cost TVA sites and approximately $50 million higher for the Savannah River site. We have not determined the reasons for these variances.

If you have any questions about this analysis, please contact me.

Yours very truly,

H. I. Bowers, Manager
Engineering Evaluations Group
Engineering Technology Division

HIB:sf

cc: J. L. Anderson
A. L. Lotts
M. L. Myers
I. Spiewak
Director, Div. of Eng., ATTN: C. Poslusny, NRR, NRC
D. Muller, DE, NRR, NRC
B. L. Grenier, NRR, NRC