CONCEPT- WNP 3+5

OAK RIDGE NATIONAL LABORATORY
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March 26, 1976

Ms. Suzanne Keblusik
Cost Benefit Analysis Branch
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Ms. Keblusik:

The enclosed memo describes the revised CONCEPT calculations requested by Mr. J. C. Petersen for the Washington Public Power Supply System, Nuclear Projects Nos. 3 and 5 and presents the results from those calculations.

Capital cost estimates for a plant provided with a heat rejection system utilizing natural draft evaporative cooling towers are presented.

For these estimates the cost models in the CONCEPT code were modified as follows: (1) spare parts allowances are 2% of the direct costs of equipment and materials, (2) contingency allowances are 10% of direct costs, and (3) indirect cost relationships for the nuclear plant were increased by ~ 60%.

The estimates produced by the CONCEPT code are not intended as substitutes for detailed engineering cost estimates, but were prepared as a rough check on the applicant's estimate.

Please contact me if I can be of further assistance.

Very truly yours,

H. I. Bowers
Engineering Analysis Dept.

HIB:sf

Enc.

cc: M. L. Myers
J. C. Petersen, NRC ✓
T. H. Row
File (BHF)

COST ESTIMATES FOR ALTERNATIVE BASE-LOAD GENERATION SYSTEMS

A recently developed computer program was used to rough check the applicant's capital cost estimate for the proposed nuclear power station and to estimate the costs for fossil-fired alternative generation systems.

This computer program, called CONCEPT[1-3] was developed as part of the program analysis activities of the AEC Division of Reactor Research and Development, and the work was performed in the Studies and Evaluations Program at the Oak Ridge National Laboratory. The code was designed primarily for use in examining average trends in costs, identifying important elements in the cost structure, determining sensitivity to technical and economic factors, and providing reasonable long-range projections of costs. Although cost estimates produced by the CONCEPT code are not intended as substitutes for detailed engineering cost estimates for specific projects, the code has been organized to facilitate modifications to the cost models so that costs may be tailored to a particular project. Use of the computer provides a rapid means of calculating future capital costs of a project with various assumed sets of economic and technical ground rules.

DESCRIPTION OF THE CONCEPT CODE

The procedures used in the CONCEPT code are based on the premise that any central station power plant involves approximately the same major cost components regardless of location or date of initial operation. Therefore, if the trends of these major cost components can be established as a function of plant type and size, location, and interest and escalation rates, then a cost estimate for a reference case can be adjusted to fit the case of interest. The application of this approach requires a detailed "cost model" for each plant type at a reference condition and the determination of the cost trend relationships. The generation of these data has comprised a large effort in the development of the CONCEPT code. Detailed investment cost studies by an architect-engineering firm have provided basic cost model data for light water reactor nuclear plants,[4-5] and fossil-fired plants.[6-7] These cost data have been revised to reflect plant design changes since the 1971 reference date of the initial estimates.

The cost model is based on a detailed cost estimate for a reference plant at a designated location and a specified date. This estimate includes a detailed breakdown of each cost account into costs for factory equipment, site materials, and site labor. A typical cost model consists of over a hundred individual cost accounts, each of which can be altered by input at the user's option. The AEC system of cost accounts[8] is used in CONCEPT.

To generate a cost estimate under specific conditions, the user specifies the following input: plant type and location, net capacity, beginning date for design and construction, date of commercial operation, length of construction workweek, and rate of interest during construction. If the specified plant size is different from the reference plant size, the direct cost for each two-digit account is adjusted by using scaling functions which define the cost as a function of plant size. This initial step gives an estimate of the direct costs for a plant of the specified type and size at the base date and location.

The code has access to cost index data files for 20 key cities in the United States. These files contain data on cost of materials and wage rates for 16 construction crafts as reported by trade publications over the past fifteen years. These data are used to determine historical trends of site labor and material costs, providing a basis for projecting future costs of site labor and materials. These cost data may be overridden by user input if data for the particular project are available.

This technique of separating the plant cost into individual components, applying appropriate scaling functions and location-dependent cost adjustments, and escalating to different dates is the heart of the computerized approach used in CONCEPT. The procedure is illustrated schematically in Fig. 1.

ESTIMATED CAPITAL COSTS

The assumptions used in the CONCEPT calculations for this project are listed in Table 1. Table 2 summarizes the total plant capital investment estimates for the proposed nuclear station.

As stated previously, the above cost estimates produced by the CONCEPT code are not intended as substitutes for detailed engineering cost estimates, but were prepared as a check on the applicant's estimate and to provide consistent estimates for the nuclear plant and fossil-fired alternatives.

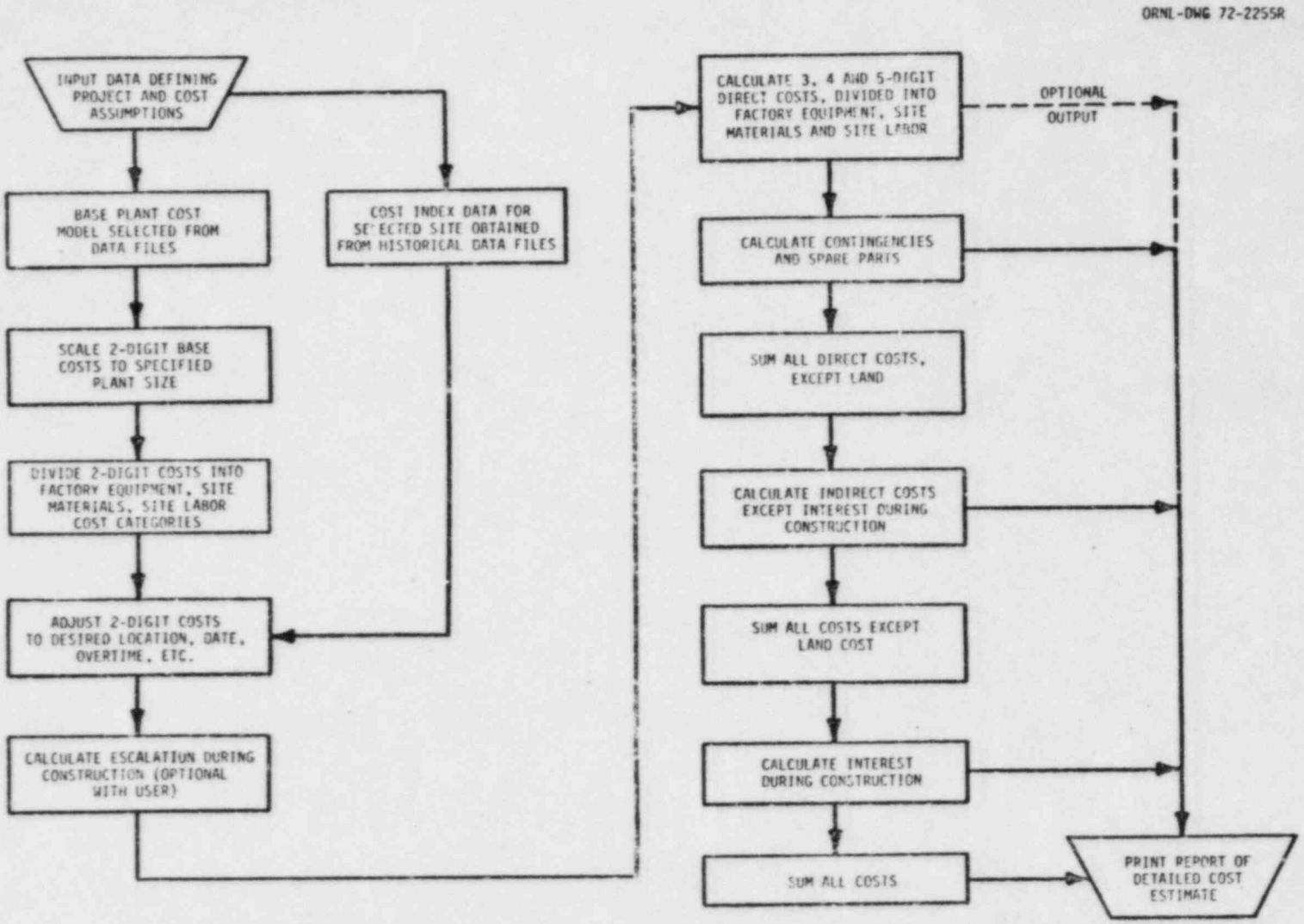

Fig. 1. Use of the CONCEPT program for estimating capital costs.

Table 1. Assumptions Used in CONCEPT Calculations
(Revised March 26, 1976)

Plant name	WPPSS Nuclear Projects Nos. 3 and 5
Plant type	Two-unit PWR with natural draft cooling towers
Alternate plant types	None
Unit size	1240 MWe-net, each unit
Plant location	
Actual	Satsop, Washington
CONCEPT calculations	Seattle
Interest during construction	7.5%/year, simple
Escalation during construction	
Site labor	8%/year
Site materials	6%/year
Purchased equipment	6%/year
Site labor requirements	10.3 manhours/kWe, unit 3 8.9 manhours/kWe, unit 5
Length of workweek	40 hours
Start of design and construction date	
NSS ordered	June 1973, Unit 3
	October 1974, Unit 5
Commercial operation dates	
Unit 3	March 1982
Unit 5	September 1983

Table 2. Plant Capital Investment Summary for a Pressurized Water Reactor Nuclear Power Plant Utilizing Natural Draft Cooling Towers

(Revised March 26, 1976)

(Washington Public Power Supply System, Nuclear Projects Nos. 3 and 5)

	Unit 3	Unit 5	Total
Net capability, MWe	1240	1240	2480
Direct Costs (Millions of Dollars)			
Land and land rights	4	0	4
Physical plant			
Structures and site facilities	88	69	157
Reactor plant equipment	113	112	225
Turbine plant equipment	125	123	248
Electric plant equipment	48	41	89
Miscellaneous plant equipment	8	5	13
Subtotal (physical plant)	382	350	732
Spare parts allowance	4	4	8
Contingency allowance	38	35	73
Subtotal (total physical plant)	424	389	813
Indirect Costs (Millions of Dollars)			
Construction facilities, equipment and services	42	19	61
Engineering and construction management services	85	39	124
Other costs	42	39	81
Interest during construction	173	142	315
Total Costs			
Plant capital cost at start of project			
Millions of dollars	770	628	1398
Dollars per kilowatt	621	506	564
Escalation during construction	298	246	544
Plant capital cost at commercial operation			
Millions of dollars	1068	874	1942
Dollars per kilowatt	861	705	783

REFERENCES

1. *CONCEPT: A Computer Code for Conceptual Cost Estimates of Steam-Electric Power Plants — Status Report*, USAEC Report WASH-1180 (April 1971).

2. R. C. DeLozier, L. D. Reynolds, and H. I. Bowers, *CONCEPT: Computerized Conceptual Cost Estimates for Steam-Electric Power Plants — Phase I User's Manual*, USAEC Report ORNL-TM-3276, Oak Ridge National Laboratory, October 1971.

3. H. I. Bowers, R. C. DeLozier, L. D. Reynolds, and B. E. Srite, *CONCEPT II: A Computer Code for Conceptual Cost Estimates of Steam-Electric Power Plants — Phase II User's Manual*, USAEC Report ORNL-4809, Oak Ridge National Laboratory, April 1973.

4. *1000-MWE Central Station Power Plant Investment Cost Study, Volume I, Pressurized Water Reactor Plant*, USAEC Report WASH-1230 (Vol. I), United Engineers and Constructors, Inc., Philadelphia, Pa., June 1972.

5. *1000-MWE Central Station Power Plant Investment Cost Study, Volume II, Boiling Water Reactor Plant*, USAEC Report WASH-1230 (Vol. II), United Engineers and Constructors, Inc., Philadelphia, Pa., June 1972.

6. *1000-MWE Central Station Power Plant Investment Cost Study, Volume III, Coal-Fired Fossil Plant*, USAEC Report WASH-1230 (Vol. III), United Engineers and Constructors, Inc., Philadelphia, Pa., June 1972.

7. *1000-MWE Central Station Power Plant Investment Cost Study, Volume IV, Oil-Fired Fossil Plant*, USAEC Report WASH-1230 (Vol. IV), United Engineers and Constructors, Inc., Philadelphia, Pa., June 1972.

8. *Guide for Economic Evaluation of Nuclear Reactor Plant Designs*, USAEC Report NUS-531, NUS Corporation, January 1969.